NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

A COMPARISON BETWEEN THE NAVY STANDARD WORKWEEK AND THE ACTUAL WORK AND REST PATTERNS OF U.S. NAVY SAILORS

by

Leonard E. Haynes

September 2007

Thesis Advisor: Nita Lewis Miller
Second Reader: David L. Schiffman

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** September 2007	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE A Comparison Between the Navy Standard Workweek and Actual Work and Rest Patterns of U.S. Navy Sailors			**5. FUNDING NUMBERS**
6. AUTHOR(S) LT Leonard E. Haynes			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			**12b. DISTRIBUTION CODE**

13. ABSTRACT (maximum 200 words)

The demands placed upon the United States Navy are greater now than ever before. As ships become more versatile, Sailors must become proficient in many warfare areas while maintaining operational readiness. The primary manning tool used by the United States Navy to determine manpower requirements is the Navy Standard Workweek. This research seeks to determine if the Navy Standard Workweek accurately reflects the activities of deployed Sailors and determine their work and rest patterns. Each Sailor completed surveys detailing tasks in which they were engaged. Survey data were compared to the Navy Standard Workweek. Individual Sailors aboard USS CHUNG-HOON (DDG-93) wore Wrist Activity Monitors to collect actigraphy data. Actigraphy data were analyzed using the Fatigue Avoidance Scheduling Tool (FAST), which uses the Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) Model, to predict the waking effectiveness level of each Sailor. The results showed that the Navy Standard Workweek does not accurately reflect the daily activities of Sailors. More importantly, based on FAST results, most Sailors had predicted effectiveness levels lower than the predicted effectiveness level of the Navy Standard Workweek Model. It is recommended that the Navy Standard Workweek be revised to more accurately reflect requirements of Sailors in different departments.

14. SUBJECT TERMS Navy Standard Workweek, FAST, SAFTE Model, Shiftwork, Circadian Rhythms, Sleep Debt, Fatigue Management, Actigraphy, Operational Manning Requirements			**15. NUMBER OF PAGES** 127
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89) Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

A COMPARISON BETWEEN THE NAVY STANDARD WORKWEEK AND THE ACTUAL WORK AND REST PATTERNS OF U.S. NAVY SAILORS

Leonard E. Haynes
Lieutenant, United States Navy
B.S., University of South Carolina, 1995

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
September 2007

Author: Leonard E. Haynes

Approved by: Nita Lewis Miller, Ph.D.
Thesis Advisor

David L. Schiffman, CDR
Second Reader

James N. Eagle, Ph.D.
Chairman, Department of Operations Research

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The demands placed upon the United States Navy are greater now than ever before. As ships become more versatile, Sailors must become proficient in many warfare areas while maintaining operational readiness. The primary manning tool used by the United States Navy to determine manpower requirements is the Navy Standard Workweek. This research seeks to determine if the Navy Standard Workweek accurately reflects the activities of deployed Sailors and determine their work and rest patterns. Each Sailor completed surveys detailing tasks in which they were engaged. Survey data were compared to the Navy Standard Workweek. Individual Sailors aboard USS CHUNG-HOON (DDG-93) wore Wrist Activity Monitors to collect actigraphy data. Actigraphy data were analyzed using the Fatigue Avoidance Scheduling Tool (FAST), which uses the Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) Model, to predict the waking effectiveness level of each Sailor. The results showed that the Navy Standard Workweek does not accurately reflect the daily activities of Sailors. More importantly, based on FAST results, most Sailors had predicted effectiveness levels lower than the predicted effectiveness level of the Navy Standard Workweek Model. It is recommended that the Navy Standard Workweek be revised to more accurately reflect requirements of Sailors in different departments.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

The demand for operational readiness in the U.S. Navy (USN) is greater today than ever before. Sailors must be proficient in many areas of warfare, while continuing to maintain the material readiness of the ship. Due to budgetary constraints, there is also increasing pressure to reduce the crew size of ships. The primary method to determine manning aboard ships of the USN is the Navy Standard Workweek. The 168 hours in the Navy Standard Workweek is divided into two categories: Available Time (81 hours) and Non-Available Time (87 hours). Available Time consists of tasks required to be performed by the Sailor such as standing watch and maintenance, and also includes training and attending meetings. Non-Available Time is comprised of all personal time that is allotted to the Sailor, and includes messing and sleeping.

This thesis poses three questions: Does the Navy Standard Workweek accurately reflect the daily duties of USN Sailors? Does the Navy Standard Workweek, as currently designed, allow for optimal manning of U.S. Navy Ships? How does current manning affect operational readiness as measured by the Fatigue Avoidance Scheduling Tool (FAST)?

To address these questions Sailors on USS CHUNG-HOON (DDG-93) wore Wrist Activity Monitors (WAMs) for 18 days and completed surveys detailing their daily activities. The survey data were compared to the Navy Standard Workweek to determine if the Navy Standard Workweek correctly reflects the daily activities of the Sailors. The data collected by the WAMs were analyzed using the Fatigue Avoidance Scheduling Tool (FAST), which uses the Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) model to predict individual effectiveness.

The results of this research suggest that the Navy Standard Workweek does not accurately reflect the daily activities of Sailors. Using the FAST tool, many Sailors' predicted effectiveness level was at or below 80%, indicating an increased chance of errors. This high level of fatigue, coupled with nighttime

watch-standing duties, can lead to ineffective watch-standing and has major implications for safety and operational risk management.

Based on the findings of this study, it is recommended that a version of the Navy Standard Workweek be developed for enlisted Sailors based on departmental assignment. A separate version of the Navy Standard Workweek should be developed for the Officers. These changes will more accurately reflect the demands placed upon the Sailors in the United States Navy and will allow for more realistic manning of U.S. Navy Ships.

ACKNOWLEDGMENTS

I would like to acknowledge Dr. Nita L. Miller and CDR David Schiffman for their unrelenting support and dedication to helping me achieve this milestone in my life and career. I would also like to extend my gratitude to CAPT Robert Firehammer and Professor Robert Koyak for their guidance throughout this endeavor. Finally, I would to like acknowledge the Sailors of USS CHUNG-HOON (DDG-93) for participating in this study; especially LCDR Adam Welter and ENS Kevin Reali, for assisting me with data collection.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A man is no sailor if he cannot sleep when he turns-in, and turn-out when he is called.

R.H. Dana

<u>Two Years Before the Mast</u>

A. OVERVIEW

"The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea" (Manual of Navy Total Force Manpower Policies and Procedures, 1998). This is the requirement for the United States Navy as set forth in United States Code Title X. However, in today's constantly evolving world, uncertain times and unpredictable events place ever higher demands on operational readiness. These challenges have placed an extraordinarily high requirement for operational readiness on the United States Navy.

To further complicate this situation, the ships of the U.S. Navy have become more versatile in nature. Illustrating this point, USS CHUNG-HOON (DDG-93) has several primary missions. These missions include anti-air warfare (AAW), surface warfare (SUW), sub-surface warfare (ASW), strike warfare, and naval surface fire support (NSFS), along with several secondary missions. In addition to training for these specific mission areas, Sailors must also complete personal qualifications such as Surface Warfare Officer or Enlisted Surface Warfare Specialist, while also studying for advancement exams in order to further their careers. Adding to the demands on their time, Sailors must perform ship maintenance and other duties as required.

Ideally, Sailors should be well rested to perform the various tasks required by the Navy. Combating fatigue in Sailors is a critical determinant of the U.S. Navy's ability to effectively perform required missions. Many of the tasks, including watch-standing, will occur at night. To man the ship continually, many

Sailors may be on a watch rotation that varies the time at which sleep can be obtained, contributing to sometimes severe disruption of the circadian cycle.

The circadian cycle, or circadian rhythm as it is more commonly known, is the body's schedule keeper. The cycle lasts approximately one day or 24 hours in length, and affects biological functions such as sleep and alertness. The circadian cycle can accommodate some variation (between 21 – 25 hrs), but the constant changes due to shipboard routine hinder this ability. To make matters worse, often when the Sailor has the opportunity to sleep, conditions such as noise, heat, vibration and odors have a negative impact on the quality and length of the sleep. If a Sailor is able to sleep during the day, light exposure, daytime noise and the body's desire to be awake may cause the quality and length of sleep to decrease.

In order to determine the personnel assigned to each class of ship, the Navy has designed a standardized version of one week of work performed while at sea. This work week is referred to as the Navy Standard Workweek. How does the Navy Standard Workweek reflect the growing requirements of the Navy? The Navy Standard Workweek allows 81 hours each week for On-Duty time or Available time. This Available Time includes work or maintenance, watch-standing, training and meetings. The remaining 87 hours is provided to the sailor for sleeping, messing and free time and is called Non-Available time.

While a ship is at sea, watches are manned according to one of three conditions of readiness. Condition I watch-standing is defined as the following: the ship is at General Quarters and at maximum readiness and all watch-stations are manned. Navy guidelines state that this condition should be sustainable for six hours. The workweek for at-sea units is calculated based on wartime sailing and Condition III watch-standing. Condition III watch-standing is normal wartime steaming. During Condition III watch-standing, the ship should be able to conduct warfare against any threat. In Condition III, all essential watch-stations along with some additional watch-stations are manned. Condition IV watch-standing is peacetime steaming. During Condition IV, only essential watch-stations are manned, allowing for the minimum number of watch-standers. The ship is unable to fight while in Condition IV.

The following study offers a glimpse into the work week of Sailors of various ranks and qualifications onboard USS CHUNG-HOON (DDG 93) during pre-deployment training while in Condition III. Prior to deploying, each ship enters a pre-deployment training cycle. During this phase, the crew of the ship is trained to conduct warfare and damage control at sea and involves running many different combat and damage control scenarios. While running these exercises, the crew is still obligated to ensure that the ship's required maintenance and emergent repairs are conducted as well as manning all applicable watch-stations.

The purpose of this research is to determine the amount of work and rest provided to Sailors during a typical pre-deployment cycle and to determine if the Navy Standard Workweek accurately reflects the actual activities of U.S. Sailors.

THIS PAGE INTENTIONALLY LEFT BLANK

II. LITERATURE REVIEW

A. SLEEP

Sleep is defined by the Merriam-Webster Dictionary as "the natural periodic suspension of consciousness during which the powers of the body are restored..." (Merriam-Webster, 2007). Dement states that sleep is defined by two distinct characteristics that separate it from sleeplike states. The first characteristic is that sleep disconnects the conscious mind from the environment. The second characteristic is that sleep is "immediately reversible" (Dement, 1999). The ability to be aroused from sleep separates it from other sleeplike states such as a coma.

Sleep is distinguished by four periods or stages of Non-Rapid Eye Movement (NREM) and a single period of Rapid Eye Movement (REM) sleep. The first stage of NREM sleep is seen when drifting in and out of sleep. The person can be easily awakened. During stage one; a person is partially aware of the environment. The second stage of NREM sleep is characterized by brain waves slowing. Throughout Stage Two sleep, individuals are easily awakened. Stanley Coren states "if you awaken people from this stage, about 7 out of 10 will tell you they really didn't think they were asleep" (Coren, 1996). Stage Three of NREM sleep is distinguished by the onset of "Delta" waves, or extremely slow brain waves. Stage Three sleep consists of approximately 20 - 50% "Delta" brain waves and signals the beginning of deep sleep. The fourth and final stage of NREM sleep consists mostly (greater than 50%) of "Delta" waves (Cohen, 1979). In the final two stages of NREM, it is difficult to awaken the sleeper. REM sleep is characterized by brain waves reaching levels associated with waking periods. It is during REM sleep that many, although not all, dreams occur.

Sleep debt is the term used to describe accumulated amount of lost sleep (Dement, 1999). For example, the average person requires 8 hours of sleep per day. If a person sleeps 7 hours per day over a five day period, the accrued sleep debt is five hours. This debt must be repaid.

It is not difficult to determine if someone is sleep deprived. There are several obvious indications that signify if a person is suffering from sleep deprivation. The following are signs of sleep deprivation: unplanned napping, falling asleep immediately upon going to bed, and a marked discrepancy between hours slept during the work week and on weekends or vacation (Bradshaw & Devereaux, 2001).

B. CIRCADIAN RHYTHM

The circadian cycle or circadian rhythm, as it is more commonly known, is the body's schedule keeper. The expression "circadian" is derived from the Latin for "circa" meaning "near" and "dies" meaning day (Dement, 1999). The cycle lasts approximately one day in length, and determines biological functions such as sleeping and alertness.

C. FATIGUE

Merriam-Webster defines fatigue as "weariness or exhaustion from labor, exertion, or stress and also as the temporary loss of power to respond that is induced in a sensory receptor or motor end organ by continued stimulation" (Merriam-Webster, 2007) but fatigue may have far-reaching consequences. Research has demonstrated that fatigue results in the inability to perform mental or physical tasks leading to a lack of cognitive effectiveness and increased accidents.

Fatigue may result from several factors. A common cause of fatigue is hours of sustained wakefulness or the time elapsed since the last rest or sleep period. The time of day, or the effect of the circadian rhythm, is also a contributing factor. Another major source of fatigue is the accumulated sleep debt. Secondary causes of fatigue are stress, inadequate nutrition or diet, and environmental conditions (Chapman, 2001).

According to the Queensland Fatigue Management Guide (2005), other factors that bring about fatigue are length of shift, previous hours and days worked, type of work being performed and time of day the work is being performed (Fatigue Management Guide, 2005). This guide also lists the following effects that are associated with fatigue: desire to sleep, lack of concentration, impaired recollection of timing and events, irritability, poor judgment, reduced capacity for effective interpersonal communication, reduced hand-eye coordination, reduced visual perception, reduced vigilance, and slower reaction times (Fatigue Management Guide, 2005).

In her dissertation which studied Royal Australian Submariners, Chapman discovered an amplification of the these behaviors occurring on the mid and early morning watches: slowed speech, delayed response to orders, incorrect sequencing of orders, delayed repetition of orders, failure to acknowledge orders, increase in vacant stares, irritability, minor altercations between personnel, and self-reported decrease in ability to acknowledge multiple sources of information (Chapman, 2001). During a combat or casualty situation these behaviors can lead to serious problems. There is always mental and physical stress caused from combating a casualty or defending the ship. When combined with fatigue, this can lead to catastrophic results.

In another good source of guidance for operational commanders to fight fatigue, the Australian military has developed a fatigue management guide which lists the following behaviors as signs of fatigue: unsatisfactory attention to personal hygiene, poor work output, slowed or slurred speech, slowed responsiveness to any stimulus, unstable posture, micro-sleeps, hallucinations, obvious forgetfulness, irritability, confusion or disorientation, headaches, and blurred vision (Fatigue Management During Operations: A Commander's Guide, 2002).

D. SHIFTWORK AND WATCH ROTATIONS

Although shiftwork has been utilized by society for hundreds of years, it is still an abnormal pattern for man. Shiftwork affects almost every part of a Sailor's life. While aboard a ship, shiftwork can have a detrimental effect on a Sailor's circadian rhythm, sleep and social life. Although shiftwork is a necessary part of shipboard life, it is necessary to understand the effects shiftwork has on the individual. When discussing shiftwork, two factors should be considered: the rate and the direction of shift rotation (Hockey, 1983).

Shift systems can be characterized in at least three different ways: permanent, rapidly rotating, and slowly rotating. Each of these will be addressed in the following paragraphs.

A permanent shift system consists of an individual working the same schedule constantly. For example, a bank manager may work permanently between the hours of 9 am to 5 pm, or a nurse may always work between 11 pm and 7 am. Working a permanent shift allows for the individual's circadian rhythm to adapt to the work and rest schedule. It also allows for the individual to maintain a constant sleep - wake cycle on their days off work. Working a permanent shift provides a consistency that ensures that circadian entrainment occurs for evening and night shiftworkers as well as day shiftworkers (Hockey, 1983).

When an individual works a rapidly rotating shift schedule, they may only work two or three shifts before moving to a different shift (Monk, 1986). Eventually, the cycle will repeat. An example of a rotating shift schedule is the three section watch rotation common aboard ships. It is believed that due to short periods of working the same shift, the circadian rhythm remains diurnal and re-entrainment of the circadian rhythm is avoided. However, working this shift requires an individual to be working outside the normal sleep - wake cycle (Monk, 1986).

A slowly rotating shift schedule allows an individual to work the same shift for a short period of time (e.g., a weekly or monthly basis) and then change to a different shift (Monk, 1986). An example of a slowly rotating shift is working during the day for one week and transitioning to an evening shift the following week. An individual's circadian rhythm can easily revert to a diurnal rhythm due to cues from society and nature. The slowly rotating shift schedule is not recommended because it suffers the disadvantages of both the permanent and rapidly rotating schedules, with none of the benefits (Hockey, 1983).

The direction of rotation also affects the circadian rhythm. Although, a permanent shift system or rapidly rotating shift is preferred for the circadian rhythm, it is suggested that a forward rotating shift (i.e., morning, evening, night) allows for easier adjustment than does a backward rotating shift (i.e., night, evening, morning) (Hockey, 1983).

Adjustment of the circadian rhythm to a new shift schedule does not occur after one night. Previous studies have shown that it takes at least one week for the circadian rhythm to adjust to a nocturnal rhythm from a diurnal rhythm (Monk, 1986). One study suggests that it may take up to 12 days for individuals to adjust their circadian rhythm (Hockey, 1983). Studies have shown that work effectiveness, like the circadian rhythm, takes up to 12 days to adjust for repetitive and simple tasks. This finding would suggest that the permanent shift is the most beneficial although this requires the individual to remain on their sleep - wake cycle on non-work days. For complex tasks that require high memory load, the rapidly rotating shift system may be preferable (Hockey, 1983). Thus, when deciding on which shift system is preferred, it is necessary to consider the task requirements.

For those personnel required to sleep during the day, the quality of sleep is often poor due to external factors such as noise, vibration and light which can trigger poor quality sleep. A disruption of the circadian rhythm can also bring about poor sleep. Fatigue can also be caused by competing social or professional factors. For individuals whose work does not occur during the day, other tasks may require the attention of the shiftworker when they would be sleeping. These issues may lead to loss of sleep or poor quality sleep (Fatigue Management Guide, 2005).

E. HUMAN PERFORMANCE MODELS OF FATIGUE

The effects of fatigue during sustained combat operations have long interested the United States military. As an example, researchers from Walter Reed Army Institute of Research developed the Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) Model (Hursh et al., 2004). The SAFTE model was developed for the Department of Defense and other governmental agencies as a way to predict performance decrements due to fatigue. It attempts to predict the cognitive effectiveness of an individual based on prior sleep episodes and can also be used in an attempt to uncover potential problems with work/sleep schedules, allowing the planners to optimize personnel scheduling.

Figure 1 shows the SAFTE model which begins with a saw-tooth shaped sleep reservoir in the box in the lower part of the figure. This sleep reservoir is full when the individual is well rested and begins to deplete as the individual is awake or active. When the individual sleeps, the sleep reservoir begins to refill. The rate at which the sleep reservoir is refilled is a function of the intensity and quality of the individual's sleep. The sleep intensity is modeled as a function of the time of day and the current level of the sleep reservoir. The quality of the sleep is governed by various external influences which appear on the left of the figure. The result is the predicted measure of an individual's effectiveness on the right side of the figure.

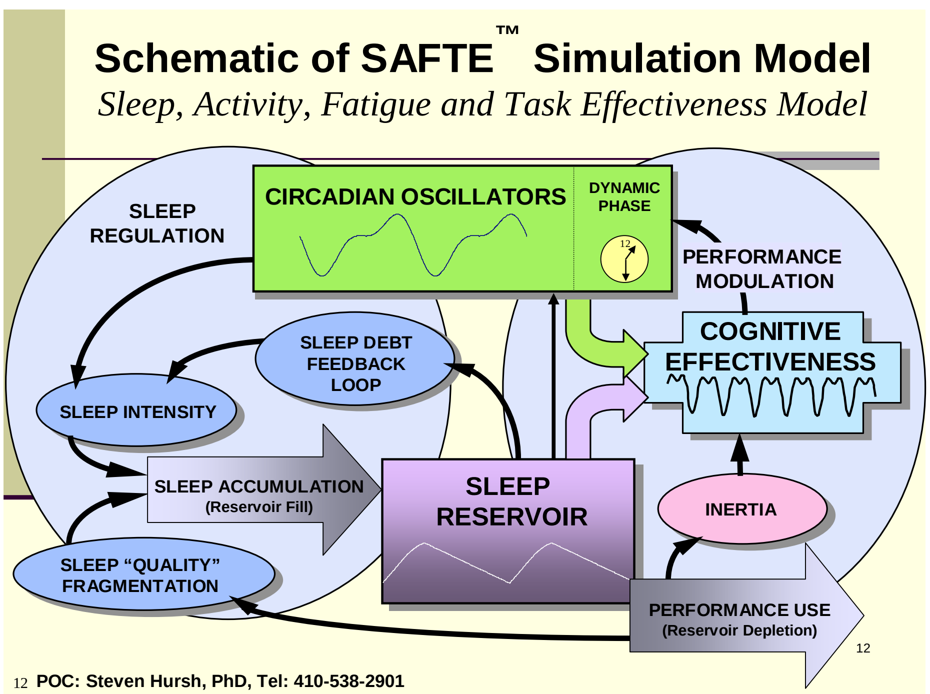


Figure 1. SAFTE Model (From Hursh et al., 2004)

The SAFTE Model has been tested using empirically derived data with remarkable predictive accuracy. The SAFTE Model produced an R^2 of .94. The SAFTE Model was selected from many competing models and has been implemented by the Department of Defense as the model of choice for determining fatigue related impairment (Hursh et al., 2004).

The Fatigue Avoidance Scheduling Tool (FAST) shown in Figure 2 uses the SAFTE Model to provide an estimate of the predicted effectiveness of an individual. Over a period of time, FAST provides a graphical representation of the estimated fatigue level of an individual. FAST also provides a blood alcohol scale to illustrate the effects of fatigue on an individual, likening it to the effects of alcohol intoxication. A lapse index is also available that shows how likely an individual is to miss a critical piece of information. Actigraphy data from sleep watches worn by individuals can be uploaded into FAST to show the predicted level of effectiveness during a given time interval.

As seen in Figure 2, periods in which the individual reports being on watch or working are shaded in red. On the left side of the FAST plot is the predicted effectiveness scale. The green horizontal band represents when the individual is operating at a predicted effectiveness of 90% or better; the yellow horizontal band represents when the individual is operating at a predicted effectiveness between 65% and 90%. The red horizontal band represents predicted effectiveness below 65%. On the right vertical axis, a Blood Alcohol Equivalence scale is used to illustrate the similarities between fatigue and alcohol intoxication and demonstrating the effects of fatigue.

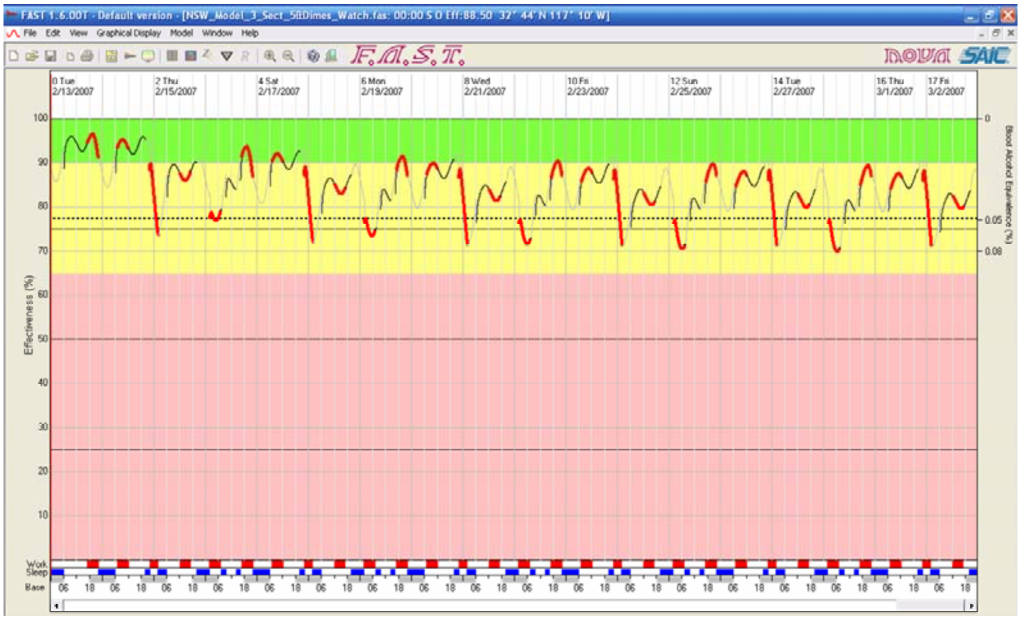


Figure 2. FAST Plot (From Version 1.600T)

F. NAVY STANDARD WORKWEEK

The Navy Standard Workweek is the official guidance used by the U.S. Navy to determine the number of personnel required to man naval vessels. It is used by the Chief of Naval Operations to determine manpower requirements and divides a standard seven day week (168 hours) into two categories: Available Time and Non-Available Time. The amount of Available Time is calculated at 81 hours, with the remaining 87 hours in the week as Non-Available Time. For “at sea” units, the workweek is based on expected wartime conditions, with units in Condition III steaming. In Condition III, the expected endurance for each crew is 60 days with 8 hours per day for rest per Sailor.

Available Time consists of standing watch, maintenance, training and meetings. Of the available time, watch-standing is allotted 56 hours per week per Sailor. Maintenance includes all required equipment upkeep and repair of the ship and is allotted 14 hours per week per sailor. Seven hours per Sailor per week is allotted for training while four hours per week is allocated for meetings.

Non-Available Time consists of all other activities and includes sleeping, messing, personal time and Sunday free time. Each Sailor is allotted 56 hours per week for sleep and 14 hours for messing and personal time. The Navy Standard Workweek provides each Sailor with three additional hours of personal time on Sunday. While these guidelines are used to determine manning requirements, a fundamental question is whether the Navy Standard Workweek accurately reflects the activities of current USN Sailors.

THIS PAGE INTENTIONALLY LEFT BLANK

III. METHODOLOGY

A. PARTICIPANTS

For this study, participants were volunteers from USS CHUNG-HOON (DDG 93), and included Sailors standing various watches or performing duties throughout the ship. Although not every participant was assigned a watch-station, each Sailor had individual requirements to fulfill. The wardroom of USS CHUNG-HOON (DDG 93) was briefed prior to data collection. A total of twenty-seven Sailors volunteered to participate in this study; and the jobs performed by participants varied according to their specialty. Additionally, the watch-stations manned by the Sailors encompassed engineering, combat information center and bridge watches.

B. IMPLEMENTATION AND DATA COLLECTION OF SLEEP DATA

1. Institutional Review Board

The study was submitted to the Institutional Review Board (IRB) at the Naval Postgraduate School to determine the level of risk to participants. It was concluded that minimal to no additional risk was involved in participating in the study. Each volunteer signed a participant consent form, a minimal risk consent statement and a privacy act statement. The IRB forms are included in Appendix A.

2. DATA COLLECTION

a. Sleep and Activity Logs

Each participant was given a self-reported Sleep and Activity Log to complete during the underway period. See Figure 3, Sleep and Activity Log. This log divided a 24-hour day into fifteen-minute blocks. The participant was asked to report daily activities to the nearest fifteen minutes each day for 18 days, dividing the day into work or Available Time and non-work or Non-Available Time. Each of these two main categories was further divided. Available Time was divided into four elements: Watch, Maintenance/Work, Training and

Meetings. Non-Available Time was also divided into four components: Sleep, Messing, Free time and Sunday Free time. Data were entered into Excel Spreadsheets for analysis. The survey data were used to determine how the Sailors were using their time.

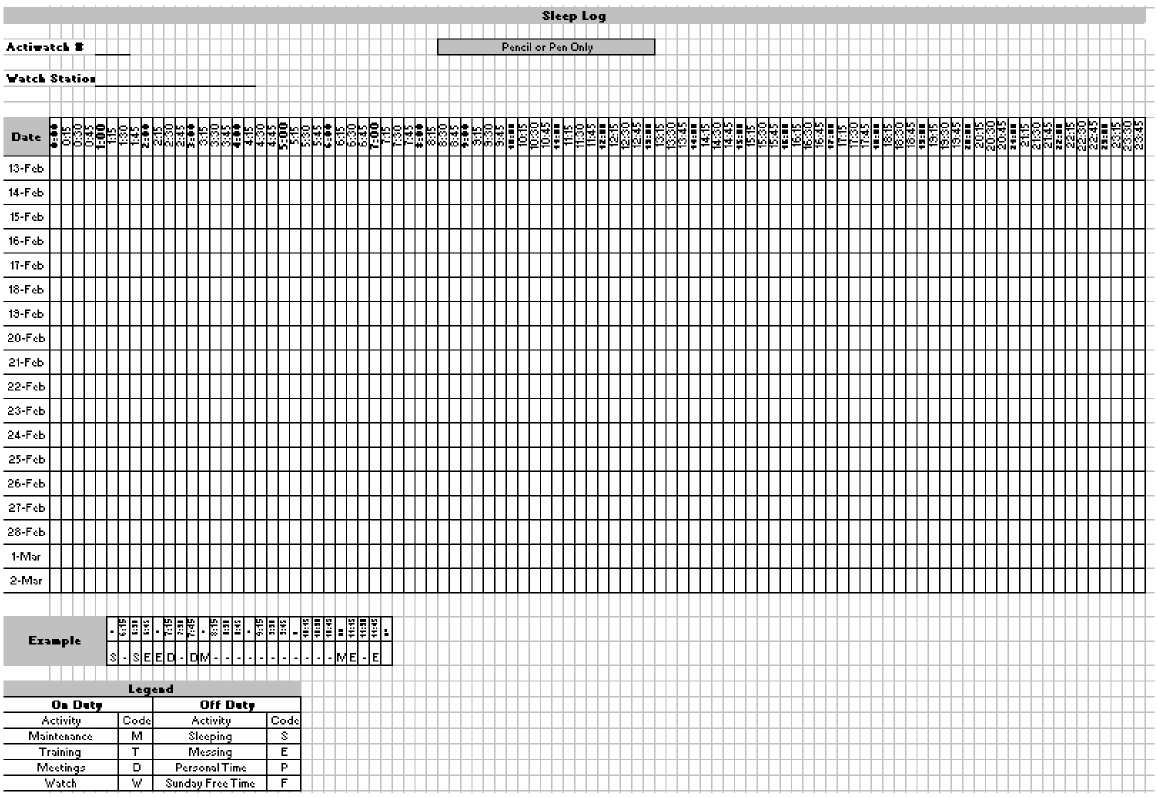


Figure 3. Sleep and Activity Log

b. *Wrist Activity Monitors*

Each participant wore a Wrist Activity Monitor (WAM) or sleep watch that recorded daily activity level for eighteen days starting on February 13, 2007 and ending on March 2, 2007. See Figure 4, Wrist Activity Monitor (AMI Model MicroMini-Motionlogger Actigraph). The serial number of the WAM was used to ensure that the WAM data were kept with the corresponding Sleep and Activity Log data. Data collection packets of Sleep and Activity Logs and WAMs were assigned to each participant at 0800 February 13, 2007 and were collected upon return to port on March 2, 2007. The data were downloaded using ActMe© software. The data were then imported into FAST for further analysis. After importing the data into FAST, the data were compared to the completed surveys to ensure that sailors were sleeping and working when they reported. Once the Sleep and Activity Logs and WAM data were compared, predicted effectiveness was calculated for all Sailors using the FAST software program.

Figure 4. Wrist Activity Monitor

THIS PAGE INTENTIONALLY LEFT BLANK

IV. RESULTS

A. DEMOGRAPHICS

Twenty-seven Sailors volunteered to participate in the study. Of the twenty-seven Sailors, two Sailors failed to complete the Sleep and Activity Log and were excluded from further analysis. The remaining twenty-five Sailors were of varied rank and positions. Two of these twenty-five Sailors did not provide a watch station, but could be identified as enlisted according to the ship's watchbill, although a positive identification between the data sets and watch-stations could not be determined. Also, five of the 27 volunteers failed to wear the WAM for the entire 18 day period and were therefore excluded from FAST data set analysis. This resulted in 25 complete self reported Sleep and Activity Logs and 22 WAM data sets.

The twenty-five Sailors with completed Sleep and Activity Logs were further separated into Officer (n = 2) and Enlisted (n = 23) (See Figure 5). The twenty-one enlisted Sailors whose watchstations were known were additionally separated into their respective departments. Combat Systems was comprised of 11 Sailors while Engineering was comprised of 6 Sailors. The remaining 4 Sailors were Operations Department personnel. Also, all Weapons Department personnel were combined with Combat Systems Department. See Figure 6 for a distribution of enlisted Sailors by Department.

The data were collected over an 18 day period. The study results focused on two weeks in the middle of the data collection period. Out of the 18 days of the study, the first two days were excluded for FAST program preconditioning; the last two days were trimmed to utilize the middle two week period. With normal preconditioning, FAST assumes that Sailors received eight hours of excellent sleep for the three days prior to the first recorded day. Since Sailors may not have been well rested prior to the study, results would have been skewed if adjustments to preconditioning was not considered. This three day period is known as preconditioning.

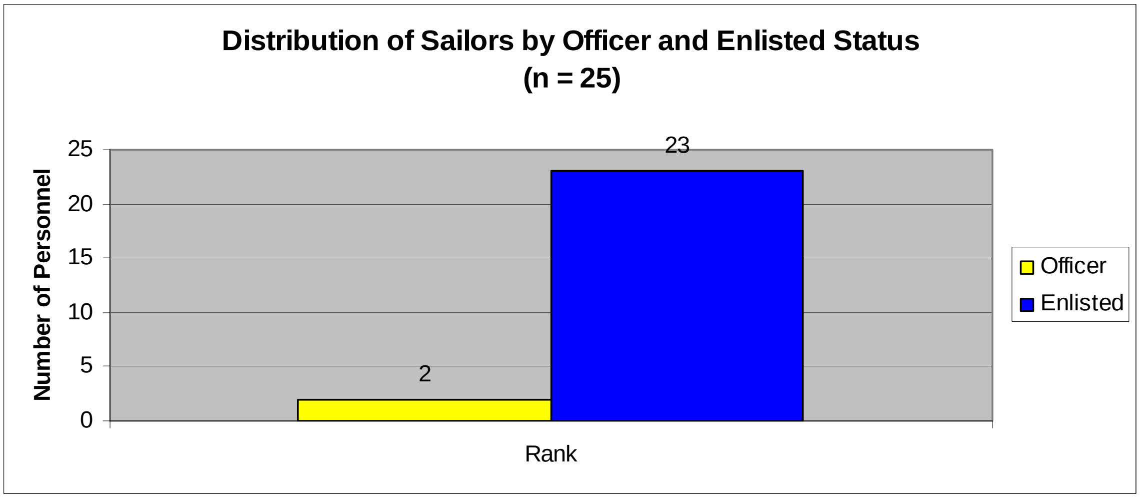


Figure 5. Distribution of Sailors by Officer and Enlisted Status

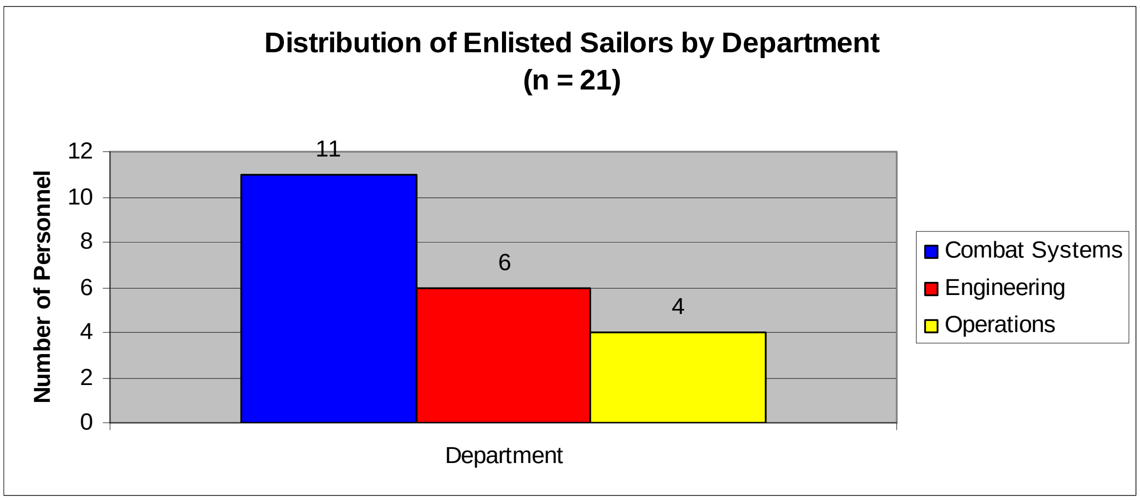


Figure 6. Distribution of Enlisted Sailors by Department

B. SLEEP AND ACTIVITY LOG RESULTS

The individual participants were asked to complete the Sleep and Activity Logs by indicating the Navy Standard Workweek category in which the individual was engaged. The resolution of the Sleep and Activity Log was 15 minutes. The data from the Sleep and Activity Logs were used to determine the amount of time each Sailor spent in each category of the Navy Standard Workweek. Due to many Sailors reporting Sunday free time as personal time, these two categories were combined. These data were compared to the requirements set forth in the

Manual of Navy Total Force Manpower Policies and Procedures (OPNAVINST 1600.J) in order to determine if the Navy Standard Workweek accurately reflected the Sailors' workweek.

Figure 7 illustrates the weekly activities of Sailor 3772. Sailor 3772 is the Combat Information Center Navplotter. Sailor 3772's watch rotation is six hours on watch followed by six hours off watch commonly referred to as "port and starboard" watch schedule. The schedule of Sailor 3772 is fairly consistent from day to day and on average he reports standing watch for 11.17 hours per day. This is over four hours more than the time allotted for watch standing by the Navy Standard Workweek. Sailor 3772 also spent 1.25 hours per day doing maintenance, forty-five minutes less than the time allotted by the Navy Standard Workweek. Sailor 3772 reported spending 1.73 hours per day in training, forty-three minutes more than the time allotted. The amount of time Sailor 3772 spent in meetings (.59 hours per day) is comparable to the time allotted by the Navy Standard Workweek (.57 hours per day). The average time Sailor 3772 spent sleeping per day was 6.28 hours, one hour and forty-three minutes less than the time allotted for sleep. Sailor 3772 spent an average of 1.23 hours per day messing compared to the 2 hours per day allowed by the Navy Standard Workweek. Sailor 3772 spent an average of 1.73 hours per day in combined Personal Time and Sunday Free Time while the Navy Standard Workweek allows for 1.21 hours of personal time per day. Appendix B has the individual Sailors, self reported time spent working contrasted to the Navy Standard Workweek.

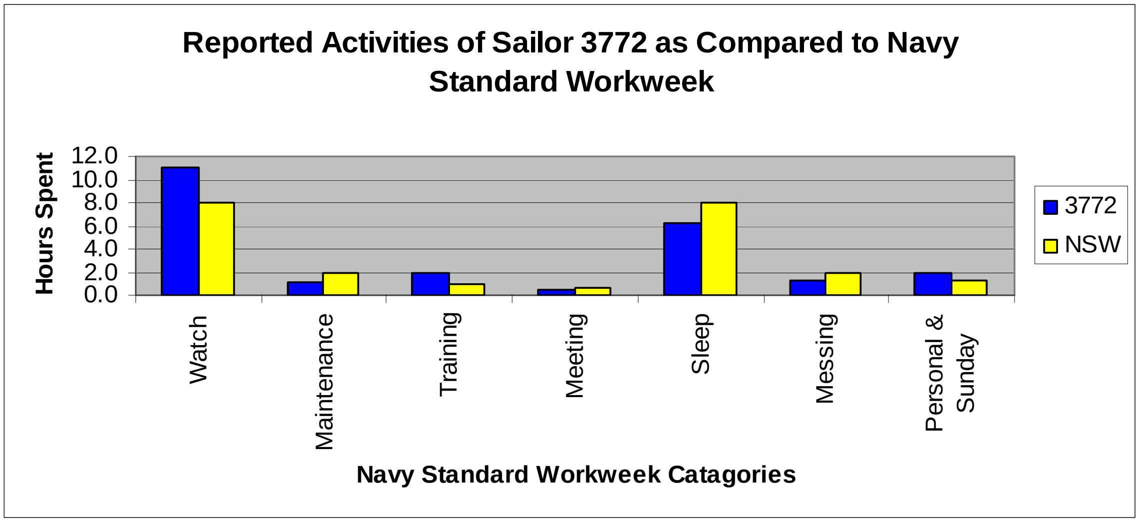


Figure 7. Reported Activities of Sailor 3772 as Compared to Navy Standard Workweek

Figure 8 illustrates the difference between the self reported activities of Sailor 3772 and the Navy Standard Workweek. The categories of watch and training exceed the time allotted by the Navy Standard Workweek, while time spent in all other categories is less than the time set forth in the Navy Standard Workweek. For this Sailor, the excess time spent in the watch and training categories is absorbed by the remainder of the categories. The differences between self reported time per category and the allocated time per category in the Navy Standard Workweek for each participant is included as Appendix C.

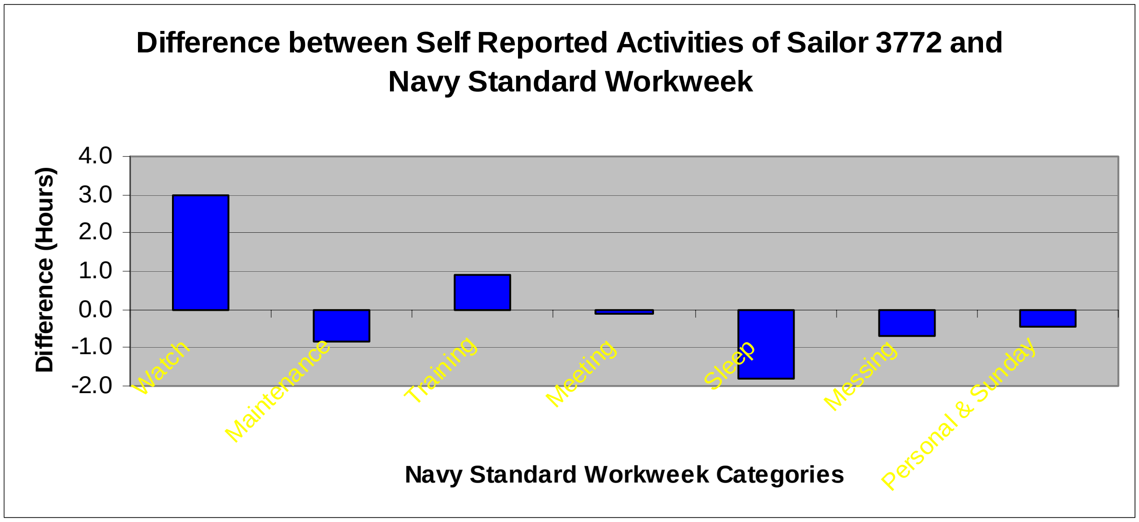


Figure 8. Difference between Self Reported Activities of Sailor 3772 and Navy Standard Workweek

Figure 9 illustrates the deviation of Sailor 3772 from the Navy Standard Workweek. The deviation was calculated using the following formula:

$$\text{Deviation} = \frac{(\text{Reported - Allotted})^2}{\text{Allotted}}$$

Sailor 3772 shows the greatest deviation from the Navy Standard Workweek in the categories of standing watch and training. The deviation between self reported time and the Navy Standard Workweek for each participant can be found in Appendix D. This deviation is an absolute value and, as such, cannot be interpreted as either positive or negative but may be a combination of both.

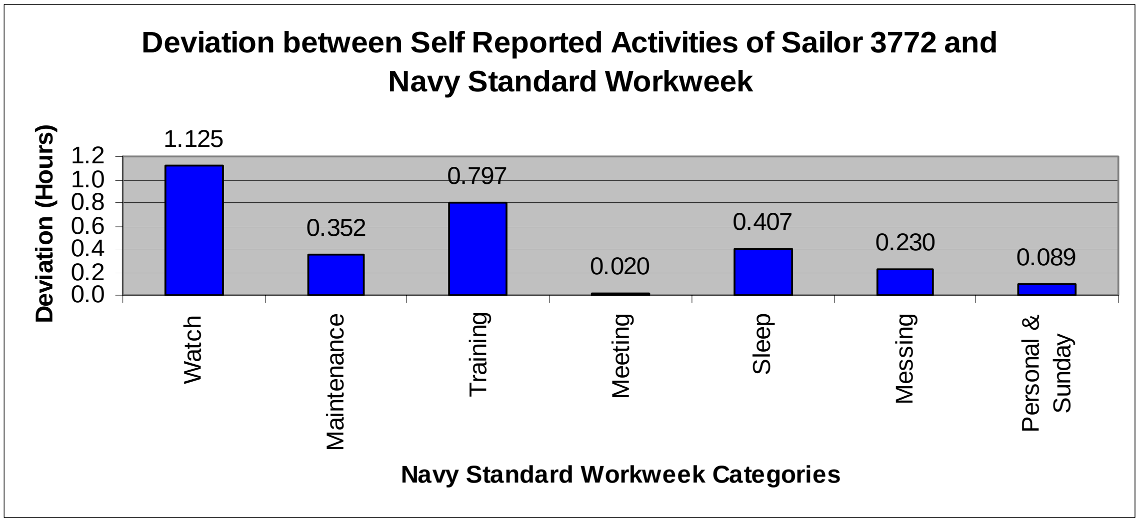


Figure 9. Deviation between Self Reported Activities of Sailor 3772 and Navy Standard Workweek

Figure 10 shows the average deviation from the Navy Standard Workweek for all Sailors in the study. The category of maintenance shows the greatest deviation followed by the category of standing watch. All other categories of the Navy Standard Workweek show less than two hours of deviation per week.

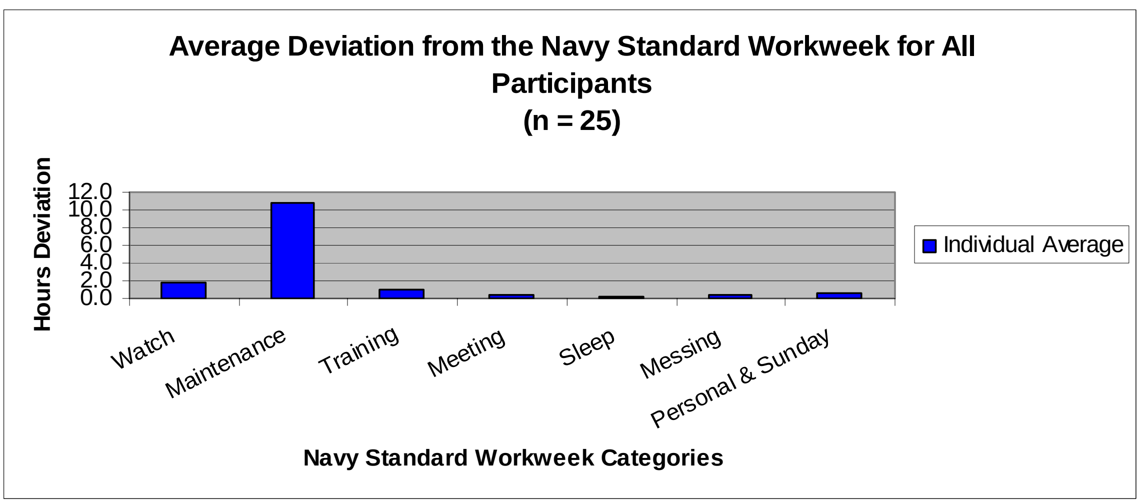


Figure 10. Average Deviation from the Navy Standard Workweek for All Participants

Figure 11 is the overall deviation by department from the Navy Standard Workweek. The Engineering Department time spent on watch is very similar to the Navy Standard Workweek, while Combat Systems and Operations show over one hour of deviation. The greatest deviation for the departments is in the category of maintenance performed by Combat Systems. Results show that Combat Systems had eleven hours of deviation from the Navy Standard Workweek in maintenance, suggesting that the Navy Standard Workweek does not adequately capture the required maintenance performed by Combat Systems personnel.

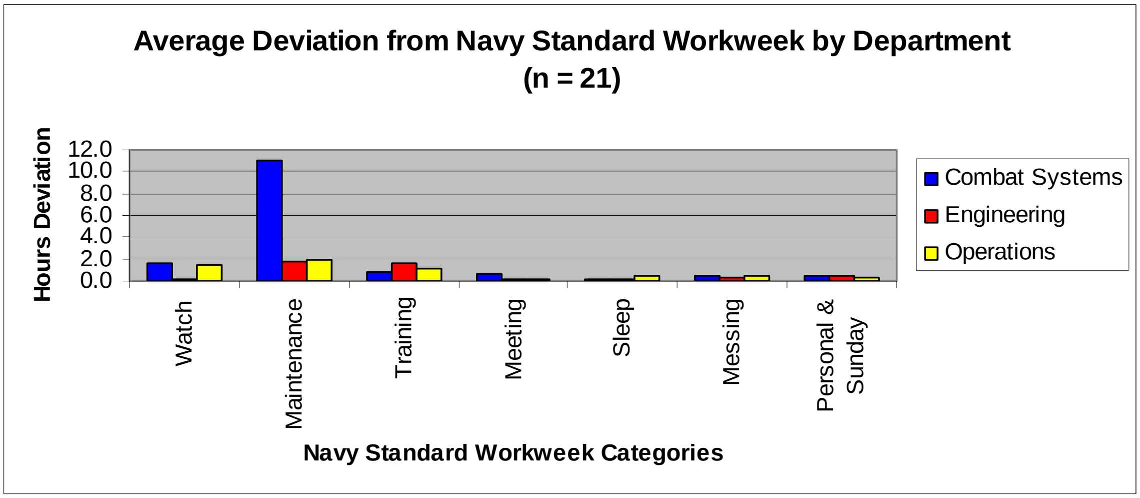


Figure 11. Average Deviation from Navy Standard Workweek by Department

Figure 12 depicts the amount of time each Sailor spent standing watch as compared to the Navy Standard Workweek. The red and green bars represent the Sailors, while the Navy Standard Workweek is shown in yellow. Those Sailors represented by red bars exceeded the time allotted by the Navy Standard Workweek for standing watch while those four Sailors in green were in compliance with the time allotted in the Navy Standard Workweek. A summary table of the Sleep and Activity Logs for each individual Sailor is located in Appendix E. Appendix F contains graphs indicating how the individual Sailors' compared to the Navy Standard Workweek by category.

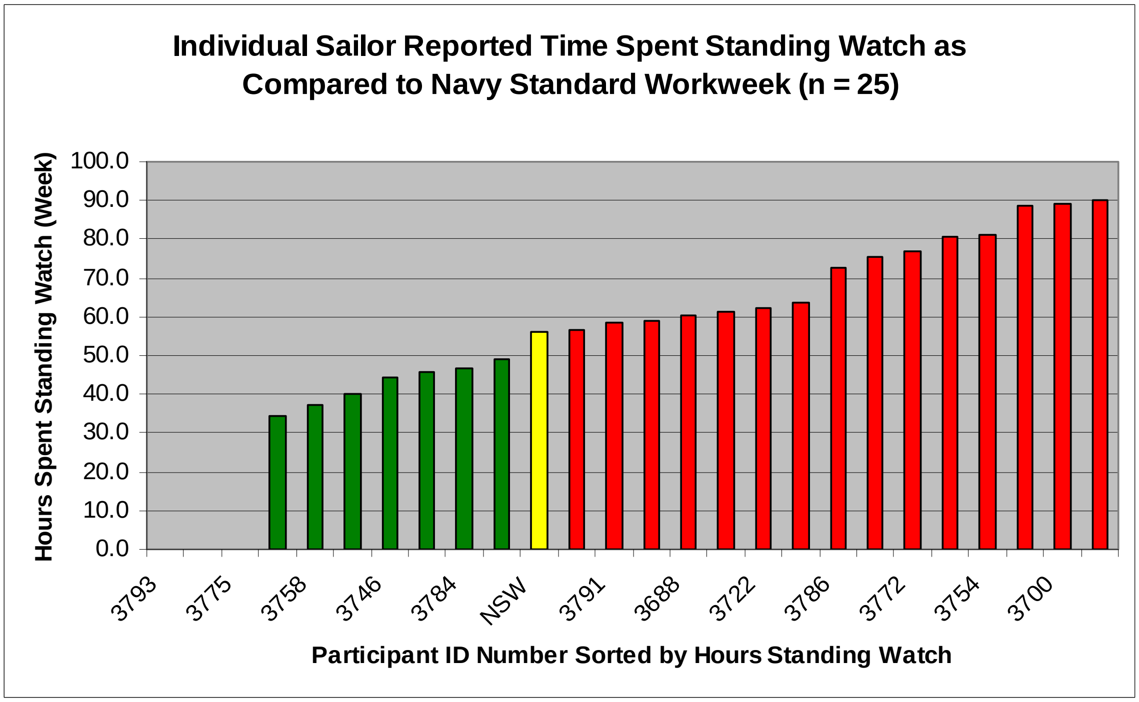


Figure 12. Individual Sailor Reported Time Spent Standing Watch as Compared to Navy Standard Workweek.

For the 168 hours per week for all participants in this survey, the average reported time spent in Available Time was 94.4 hours per week, while the average reported time spent in Non-Available Time was 73.6 hours per week. The standard deviation in both cases was 11.86 hours. Sailor 3791 spent the most hours in Available time with 117.97 hours. Sailor 3784 spent the least hours in Available time with 71.85 hours. Of the 25 Sailors participating in the survey, 22 (84%) exceeded the 81 hours allotted to Available Time by the Navy Standard Workweek. Appendix G is a table summarizing the hours each individual Sailor spent in Available Time and Non-Available Time.

Figure 13 clearly shows that Sailors onboard USS CHUNG-HOON (DDG-93) are working more than the maximum time allocated by the Navy Standard Workweek. The left vertical axis represents the number of hours individual Sailors reported spending in Available Time per week. The weekly Available Time (81 hours), set by the Navy Standard Workweek, is represented by the yellow bar. Depicted by green bars, only four Sailors reported less than the allotted 81 hours of Available Time per week, meaning that only these four Sailors were in compliance with the requirements set by the Navy Standard Workweek. Those Sailors depicted by red bars exceeded the threshold of 81 hours established by the Navy Standard Workweek. On the right vertical axis of Figure 13, the cumulative percentage of reported Available Time is illustrated. For example, the yellow bar representing the Navy Standard Workweek indicates 81 hours per week in Available Time. This corresponds to 23% of the Sailors reporting 81 hours or less per week in Available Time

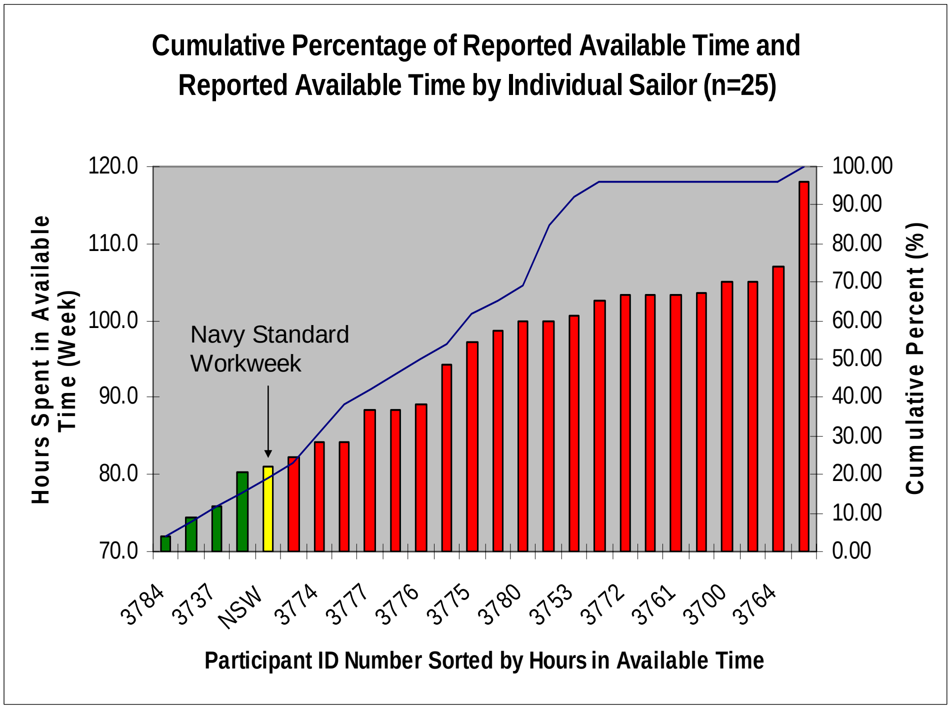


Figure 13. Cumulative Percentage of Reported Available Time and Reported Available Time by Individual Sailor

Figure 14 is the sum of the total deviations from the Navy Standard Workweek by department. The total deviation is always positive due to squaring of the residuals. The Combat Systems Department shows greater than fifteen hours deviation from the Navy Standard Workweek. The Engineering Department shows the least deviation with just over 4.5 hours of total deviation.

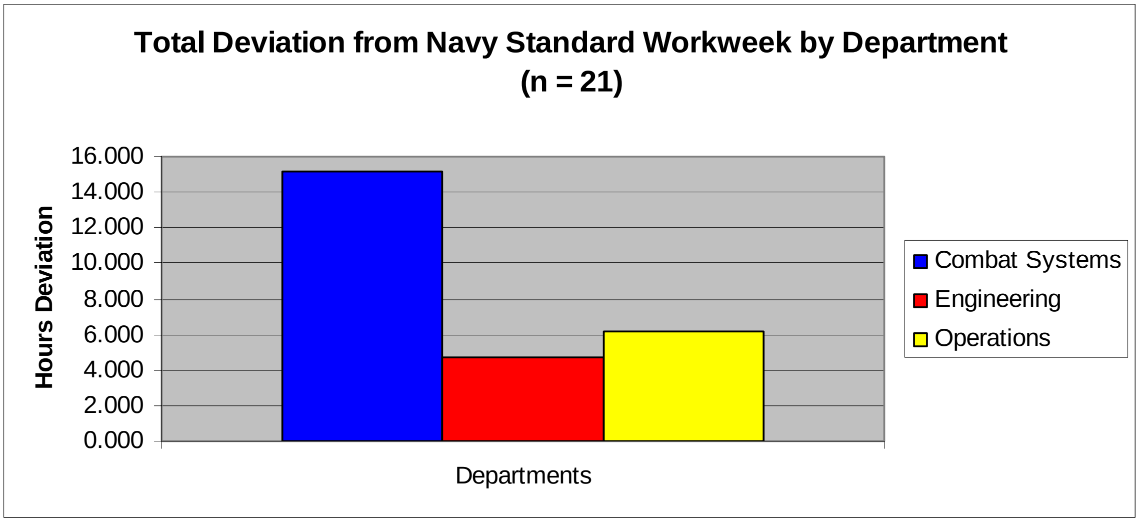


Figure 14. Total Deviation from Navy Standard Workweek by Department

C. FAST RESULTS

The actigraphy data were entered into FAST to allow prediction of the effectiveness of each individual. Figure 15 illustrates the Navy Standard Workweek in FAST. The watch rotation shown is a three section watch commonly referred to as "five and dime" in which a Sailor stands watch for five hours, then gets 10 hours off watch. Throughout the entire period, the Sailor remains above the 70% predicted effectiveness level with an average predicted effectiveness of 83.26%. Unlike the Sailors who participated in this study, this notional Sailor working the Navy Standard Workweek in Figure 16 enjoys at least four hours of contiguous sleep.

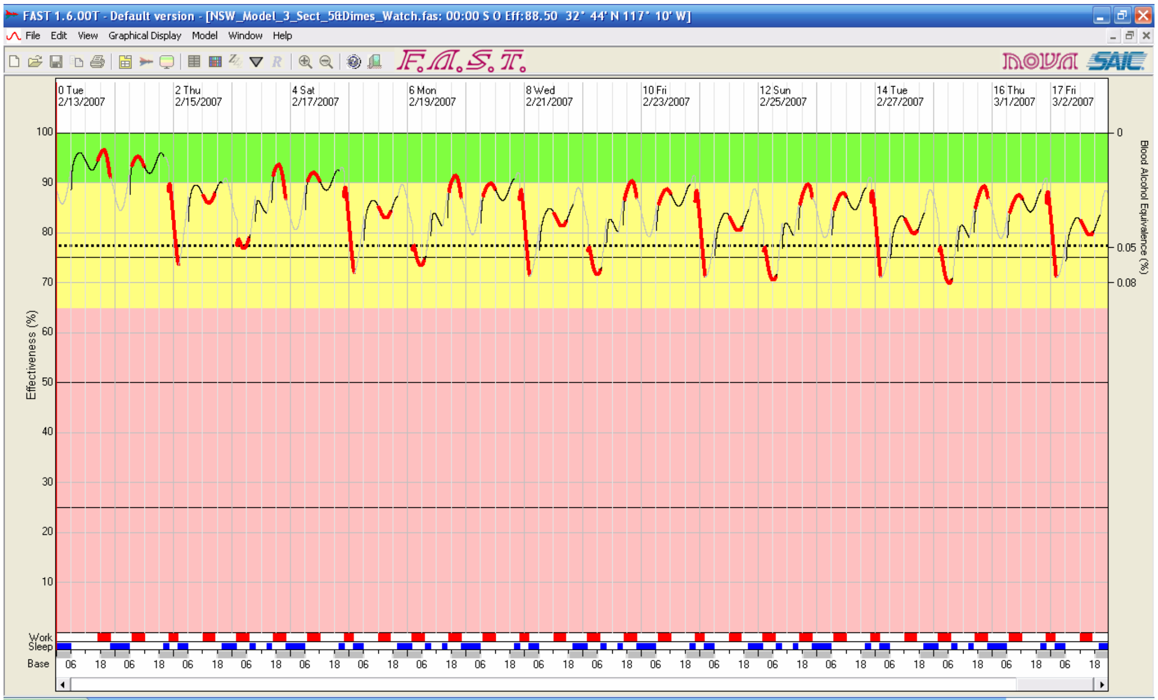


Figure 15. FAST model of Navy Standard Workweek

Figure 16 is the two-week FAST profile for Sailor 3772 who is representative of participating Sailors in this study. The red shading along the predicted effectiveness line and at the bottom of the graph indicates the time when Sailor 3772 reported being on watch. The predicted effectiveness of Sailor 3772 begins to trend downward, and on the second day, after getting underway falls below the critical 65% predicted effectiveness level. Sailor 3772 has disrupted sleep after getting underway. This fact, coupled with the constantly rotating watch shift, results in Sailor 3772 operating at less than 65% predicted effectiveness level. Throughout the remaining operational period, Sailor 3772 never reaches the 90% predicted effectiveness. It is interesting to note on Saturday 24 Feb Sailor 3772's predicted effectiveness rises from 50% to 81% following 8.25 hours of uninterrupted sleep. FAST profiles for each participant over the course of the study can be found in Appendix H.

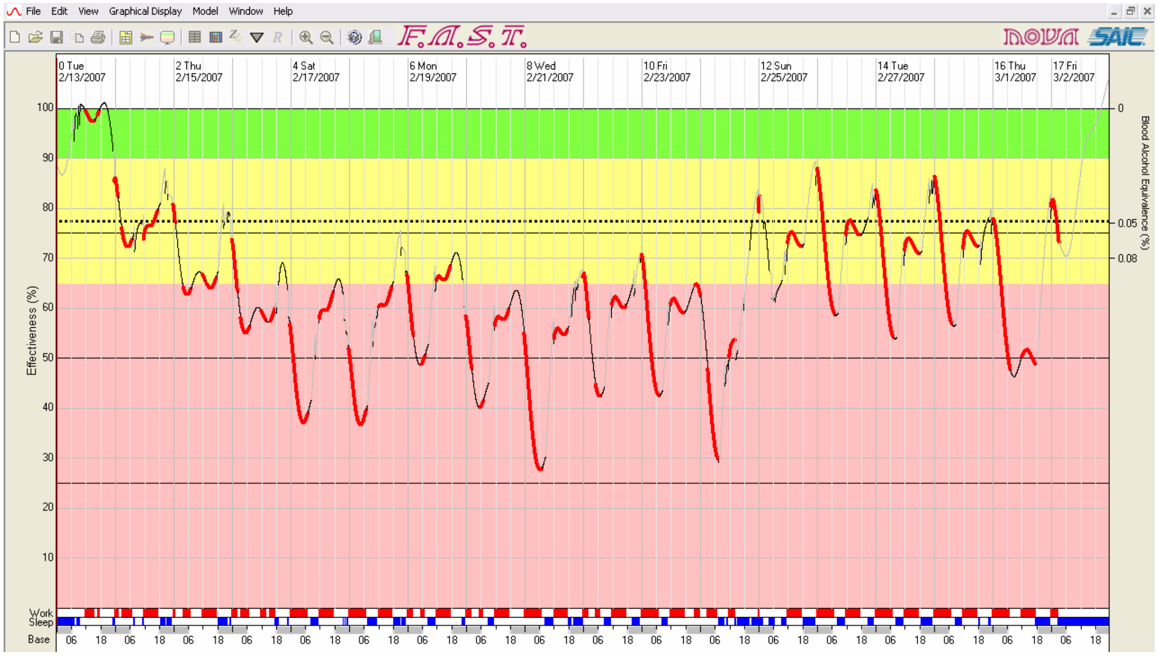


Figure 16. Sailor 3772 Two Week FAST Profile

Figure 17 is the bar chart showing the average predicted effectiveness of the Sailors versus the predicted effectiveness of the Navy Standard Workweek. The Navy Standard Workweek clearly shows the benefits from receiving more sleep and contiguous sleep.

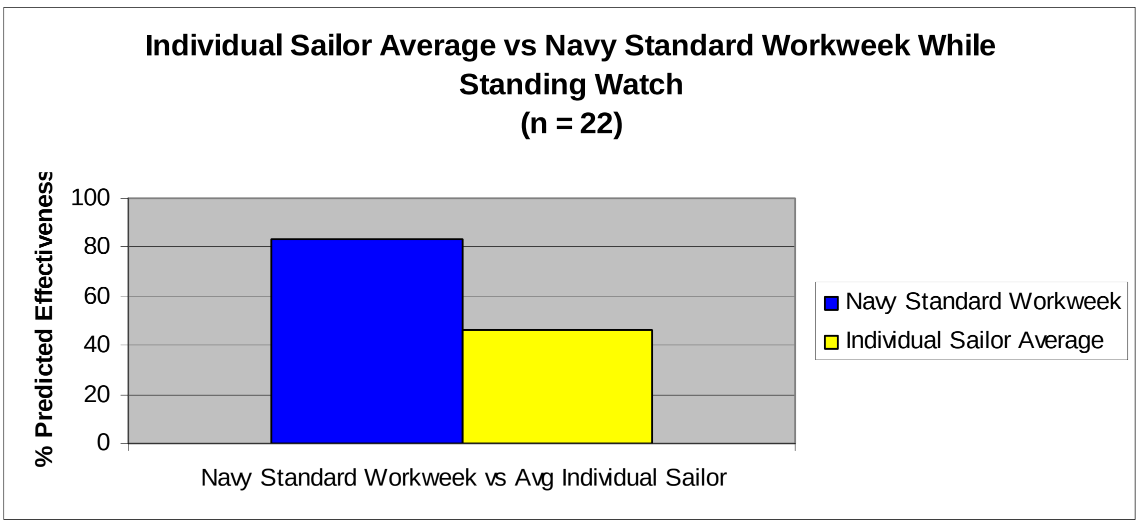


Figure 17. Individual Sailor Average Predicted Effectiveness vs Navy Standard Workweek

Appendix I is a table that summarizes the average predicted effectiveness level for each Sailor in the study. Note that Sailor 3722, the Propulsion and Auxiliary Console Operator, has the lowest average predicted effectiveness (51.9%). Sailor 3758, ESS Supervisor, has the highest predicted effectiveness (97.8%). Sailor 3758 reported getting at least four hours contiguous sleep per sleep period.

Appendix J displays a summary table of the average time spent in each category of the Navy Standard Workweek between Officers and Enlisted Personnel. Also included in the table is a breakdown between the Engineering Department and Non-Engineering (Combat Systems and Operations) Departments. The Non-Engineering Departments are also compared to each other.

THIS PAGE INTENTIONALLY LEFT BLANK

V. CONCLUSIONS AND RECOMMENDATIONS

> Here the General slept before the battle of Tannenberg; here also the General slept after the battle; and between you and me during the battle also.
>
> Attributed to General Max Hoffman (1915)

A. CONCLUSIONS

Today's uncertain world places ever greater demands upon Sailors of the United States Navy. With missions ranging from Anti-Air Warfare and Surface Warfare to humanitarian missions, Sailors are required to be multifaceted. The Navy Standard Workweek must evolve to reflect this increased demand to ensure that Sailors are prepared to perform the tasks required of them.

When the Navy Standard Workweek model is input into FAST, a Sailor who is fully compliant has a predicted effectiveness level of 83.25%. In this study, only 41% of the Sailors participating had a predicted effectiveness equal to or higher than 83.25%. Fifty-six percent of the Sailors in this study had predicted effectiveness levels of 80% or lower, suggesting that the Sailors were chronically fatigued. This finding is supported by anecdotal data. Information gathered from entering schedules into FAST may give the Commander insight into how their subordinates are expected to perform and their predicted fatigue levels.

For Sailors participating in this study, 85% exceeded the 81 hours of Available time allotted by the Standard Navy Workweek. On average, Sailors in the current study worked 16.95 hours per week more than they were allotted in the Navy Standard Workweek. This equates to 2.4 hours more per day in Available Time. Since there are a finite number of hours in a week, this extra time must be drawn from some other source. Consequently, the extra hours are wrenched from the Non-Available time allotted to each Sailor. The findings of this thesis strongly suggest that the Navy Standard Workweek does not accurately reflect the activities of today's Sailors.

B. RECOMMENDATIONS

The Navy Standard Workweek is a valuable tool for determining manpower requirements. As such, it should truthfully reflect the requirements of the U.S. Navy Sailors. Departments vary in their deviation from the Navy Standard Workweek. While some departments show little deviation in some categories, other departments deviate greatly from the Navy Standard Workweek. This is not surprising since each department has different requirements and responsibilities. It is foolish to assume that each department is the same so the same Navy Standard Workweek should not be used to determine the manpower requirements for all Departments.

It is recommended that a version of the Navy Standard Workweek be developed for each department. This would allow for the individual requirements of each department to be more accurately reflected and manning can then be done accordingly. It is also recommended that a version of the Navy Standard Workweek be developed for the Surface Warfare Officer Community that is separate from the enlisted community.

It is also recommended that this study be repeated using more participants and additional vessel types for a longer time span to derive better estimates to build this revised Navy Standard Workweek. Once developed, this revised Navy Standard Workweek should be tested in the Fleet to determine its utility. Feedback from the Sailors who test this new Navy Standard Workweek should be obtained to determine if it is effective in increasing their performance, reducing their fatigue level, and enhancing their quality of life.

APPENDIX A. PARTICIPANT CONSENT FORM, MINIMAL RISK STATEMENT, PRIVACY ACT STATEMENT

Naval Postgraduate School

Participant Consent Form & Minimal Risk Statement

Introduction. You are invited to participate in a study entitled **Analyzing Performance Deviations Using Sleep Patterns of a U.S. Navy Surface Ship Crew** being conducted by the Naval Postgraduate School Operations Research Department.

Procedures. If I agree to participate in this study, I understand I will be provided with an explanation of the purposes of the research, a description of the procedures to be used, identification of any experimental procedures, and the expected duration of my participation. *Synopsis*: (1) You may be asked to wear a wristwatch data collection device continuously, to include normally scheduled sleep periods. (2) You will be asked to fill out a log with specific information related to your schedule, particularly times related to sleep and rest periods. (3) You will be asked to complete a weekly survey of mood state.

Risks and Benefits. I understand that this project does not involve greater than minimal risk and involves no known reasonably foreseeable risks or hazards greater than those encountered in everyday life. I have also been informed of any benefits to myself or to others that may reasonably be expected as a result of this research.

Compensation. I understand that no tangible reward will be given. I understand that a copy of the research results will be available at the conclusion of the experiment.

Confidentiality & Privacy Act. I understand that all records of this study will be kept confidential and that my privacy will be safeguarded. No information will be publicly accessible which could identify me as a participant, and I will be identified only as a code number on all research forms. I understand that records of my participation will be maintained by NPS for five years, after which they will be destroyed.

Voluntary Nature of the Study. I understand that my participation is strictly voluntary, and if I agree to participate, I am free to withdraw at any time without prejudice.

Points of Contact. I understand that if I have any questions or comments regarding this project upon the completion of my participation, I should contact the Principal Investigators, Dr. Nita Lewis Miller, DSN 756-2281, nlmiller@nps.edu or LT Leonard E. Haynes, USN, (864) 884-3974, lehaynes@nps.edu. Any medical questions should be addressed to LTC Eric Morgan, MC, USA, (CO, POM Medical Clinic), (831) 242-7550, eric.morgan@mw.amedd.army.mil.

Statement of Consent. I have read and understand the above information. I have asked all questions and have had my questions answered. I agree to participate in this study. I will be provided with a copy of this form for my records.

___________________________________ ___________________

Participant's Signature Date

___________________________________ ___________________

Researcher's Signature Date

Privacy Act Statement

1. Authority: Naval Instruction

2. Purpose: Activity levels, Profile of Mood State, and watch rotation data will be collected to enhance knowledge, and to develop recommendations for scheduling practices of Naval Surface Sailors.

3. Use: Data will be used for statistical analysis by the Departments of the Navy and Defense, and other U.S. government agencies, provided this use is compatible with the purpose for which the information was collected. Use of the information may be granted to legitimate non-government agencies or individuals by the Naval Postgraduate School in accordance with the provisions of the Freedom of Information Act.

4. Disclosure/Confidentiality:

   a. I have been assured that my privacy will be safeguarded. I will be assigned a control or code number, which thereafter will be the only identifying entry on any of the research records. The Principal Investigator will maintain the number. In all cases, the provisions of the Privacy Act Statement will be honored.

   b. I understand that a record of the information contained in this Consent Statement or derived from the experiment described herein will be retained permanently at the Naval Postgraduate School or by higher authority. I voluntarily agree to its disclosure to agencies or individuals indicated in paragraph 3 and I have been informed that failure to agree to such disclosure may negate the purpose for which the experiment was conducted.

   c. I also understand that disclosure of the requested information, including my Social Security Number, is voluntary.

____

Signature of Volunteer Name, Grade/Rank (if applicable)

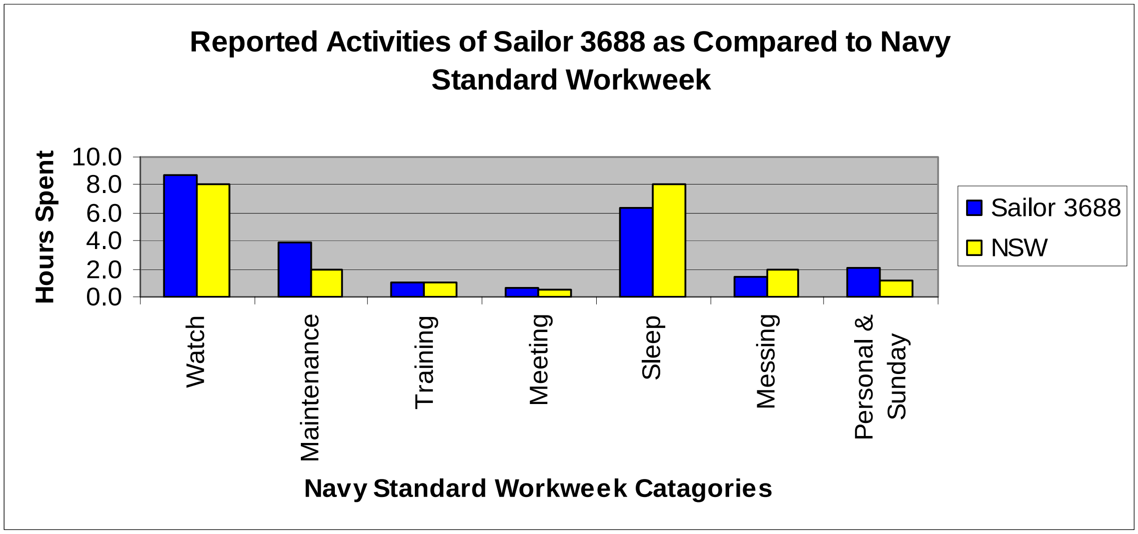
____

DOB SSN Date

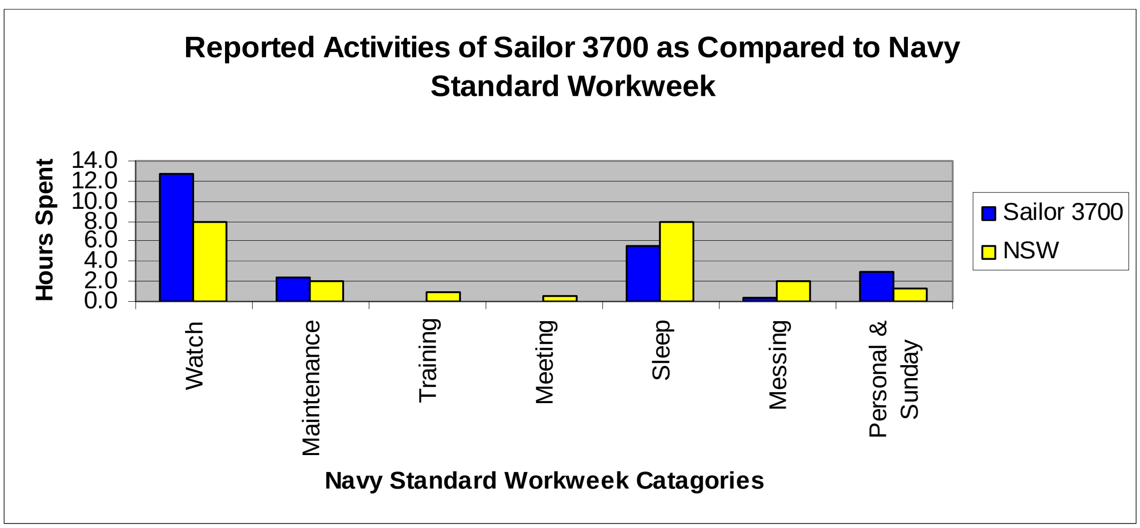
____

Signature of Witness Date

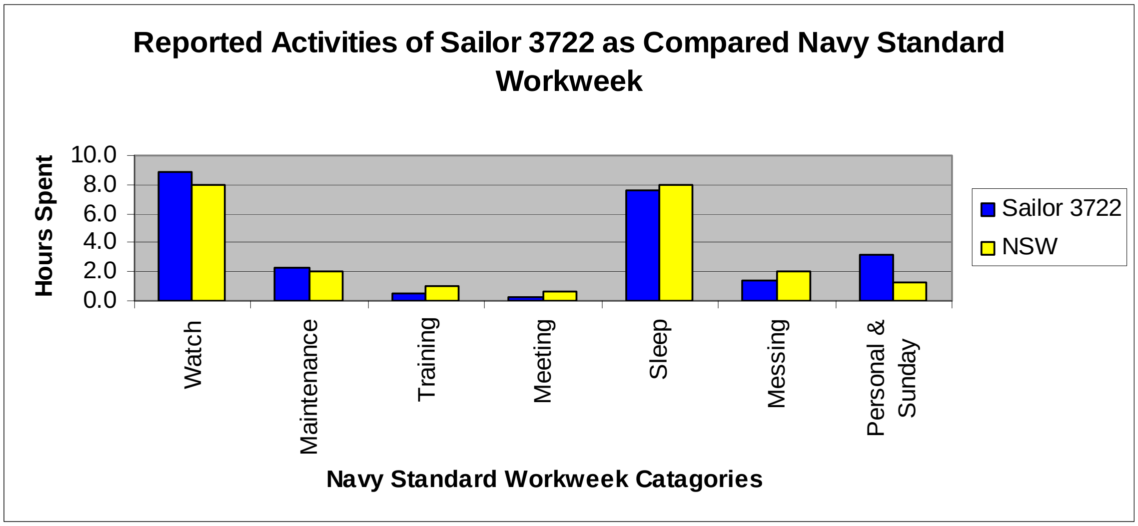
APPENDIX B. INDIVIDUAL SAILOR DAILY REPORTED VS NAVY STANDARD WORKWEEK



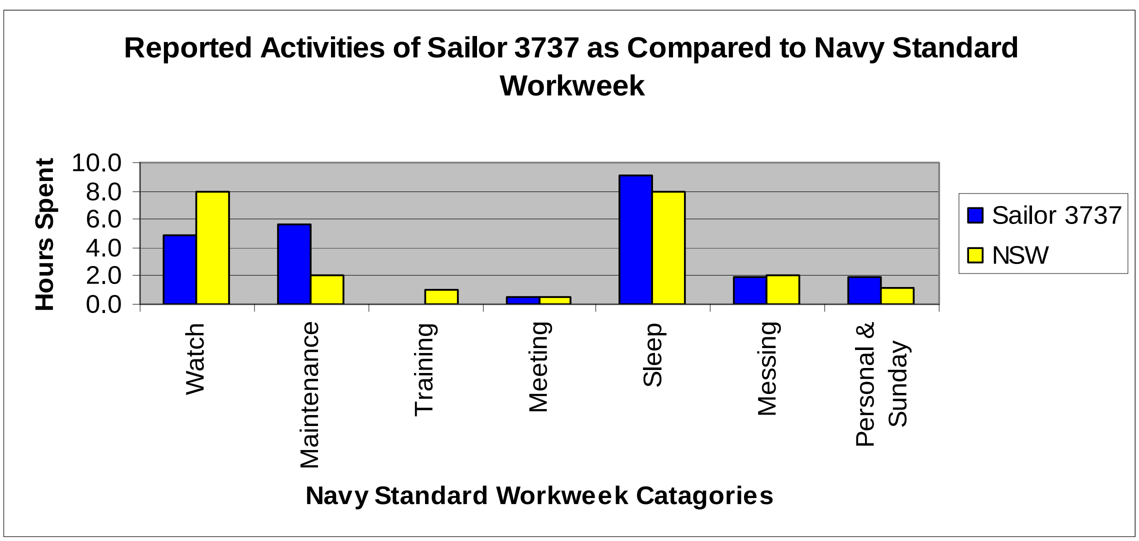
3688



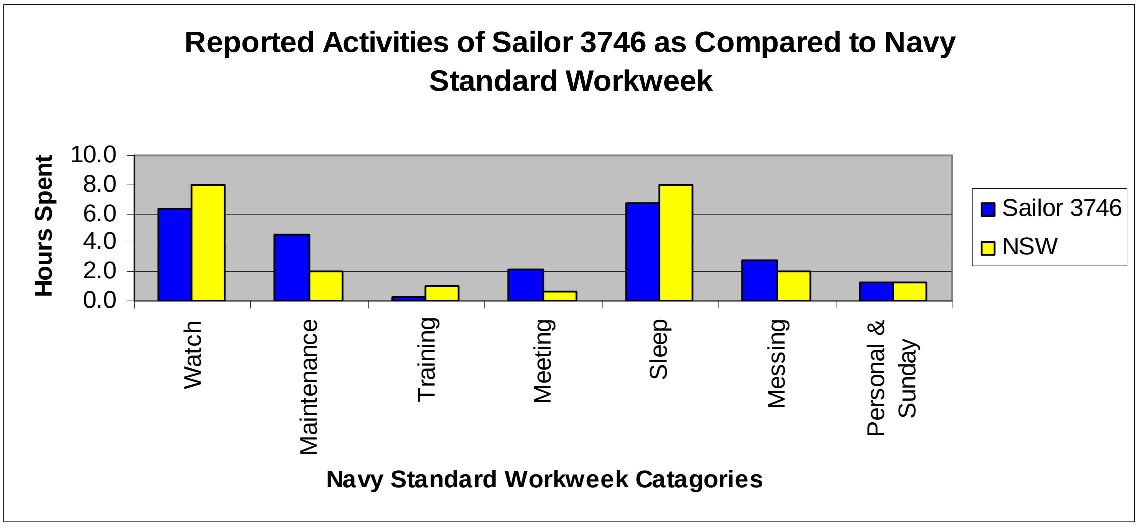
3700


Reported Activities of Sailor 3722 as Compared Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3722
NSW

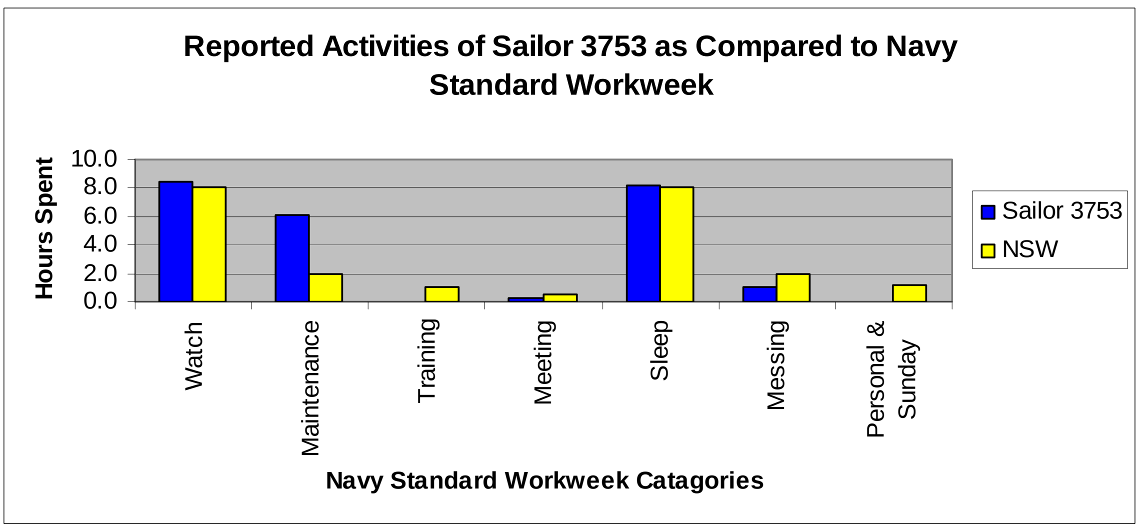
3722


Reported Activities of Sailor 3737 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3737
NSW

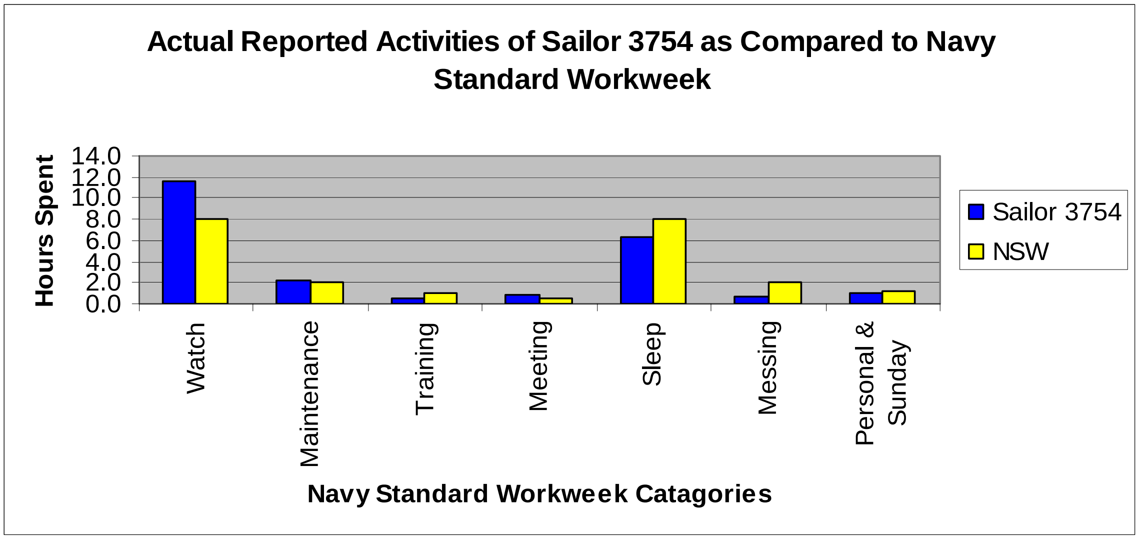
3737


Reported Activities of Sailor 3746 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3746
NSW

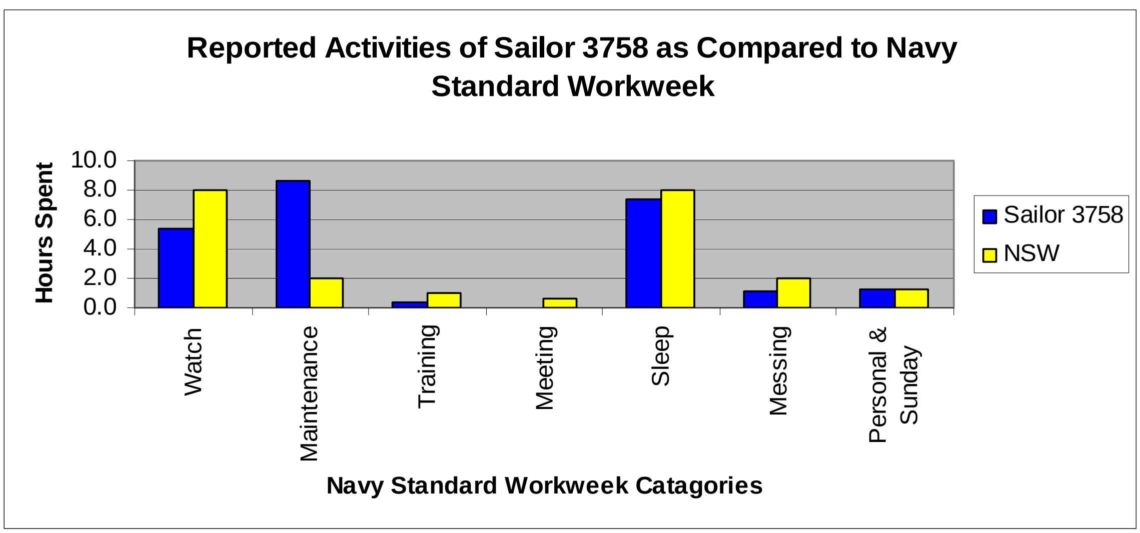
3746


Reported Activities of Sailor 3753 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3753
NSW

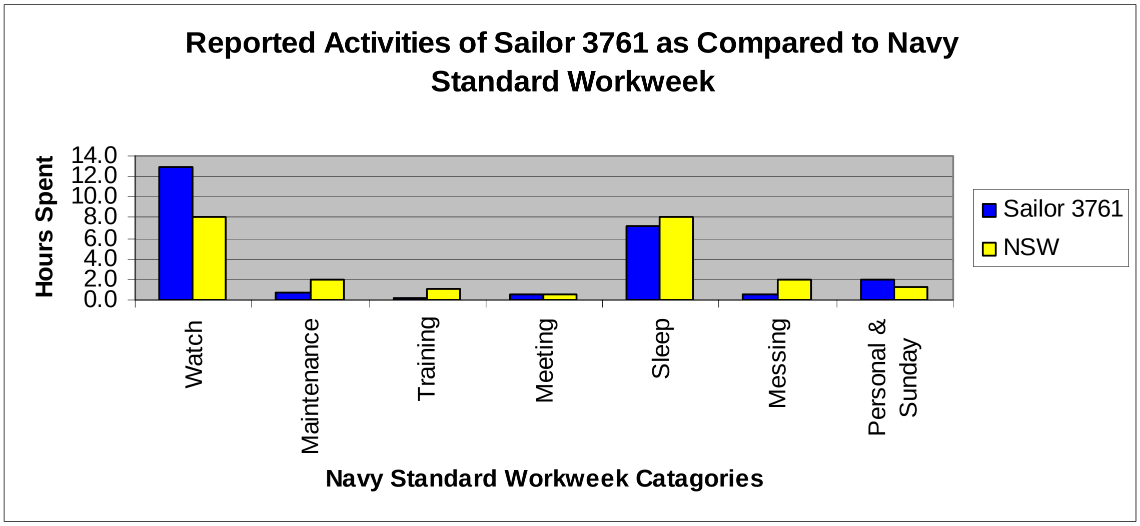
3753


Actual Reported Activities of Sailor 3754 as Compared to Navy Standard Workweek
Hours Spent
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3754
NSW

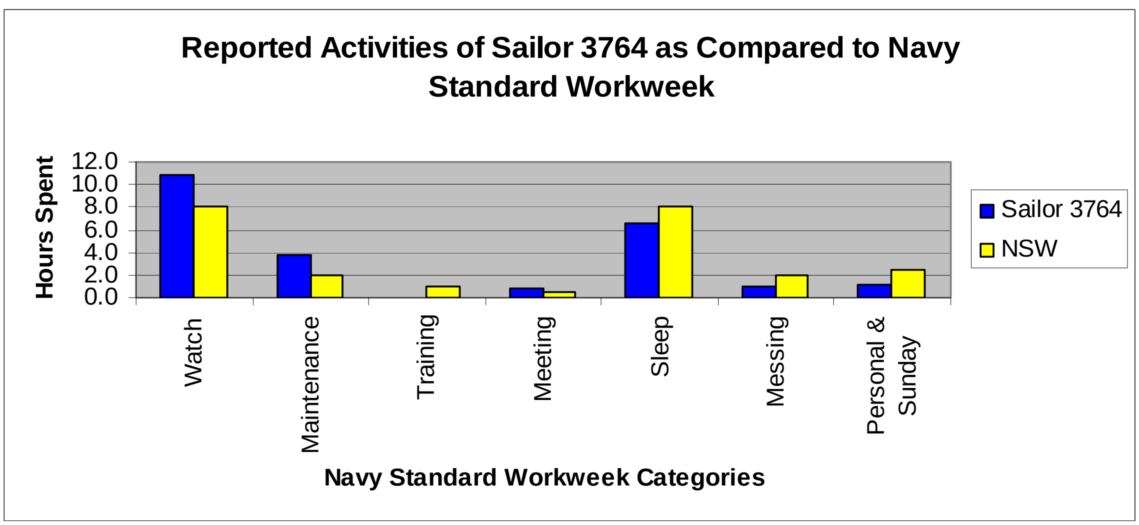
3754


Reported Activities of Sailor 3758 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3758
NSW

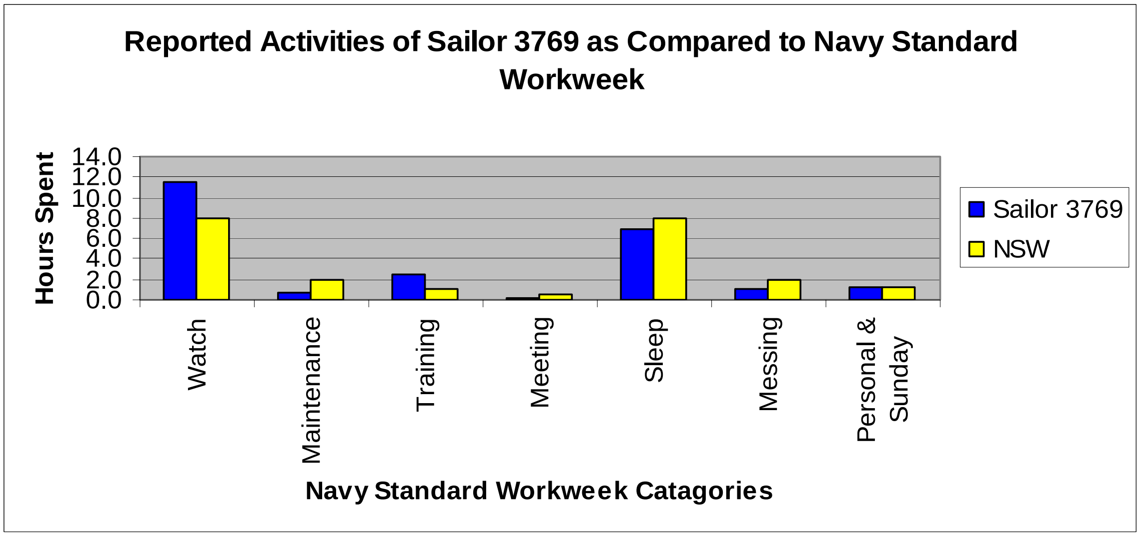
3758


Reported Activities of Sailor 3761 as Compared to Navy Standard Workweek
Hours Spent
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3761
NSW

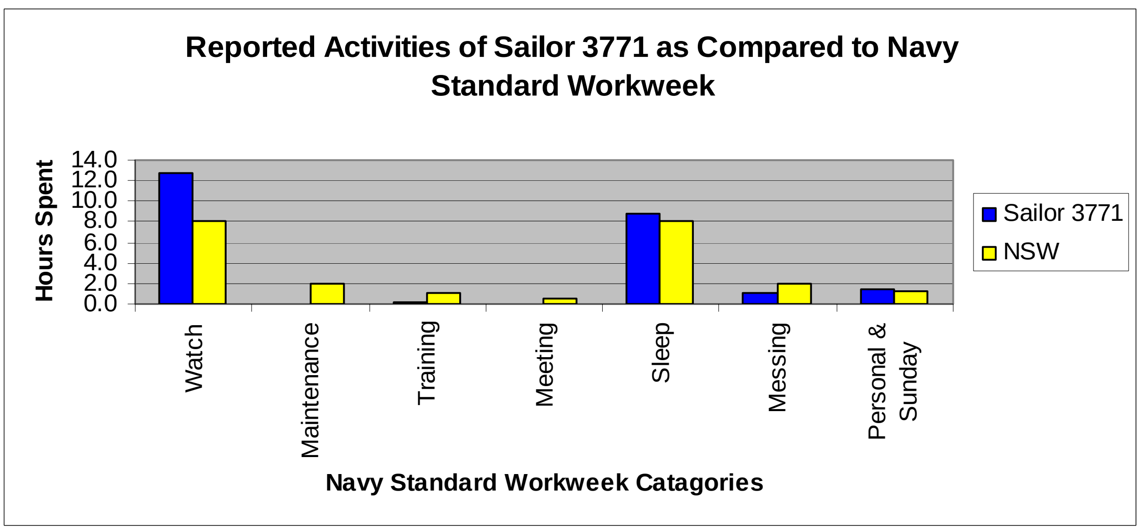
3761


Reported Activities of Sailor 3764 as Compared to Navy Standard Workweek
Hours Spent
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories
Sailor 3764
NSW

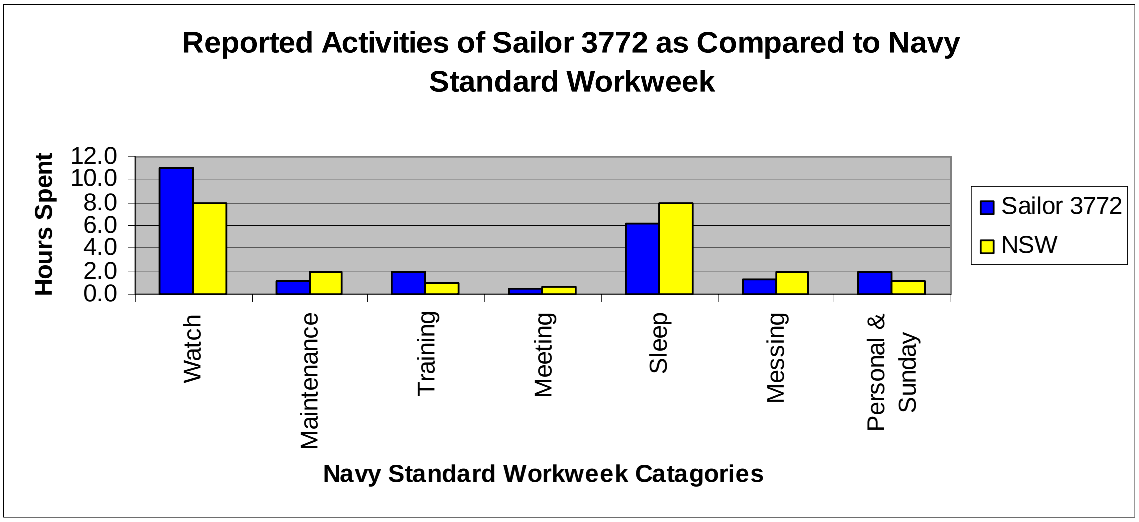
3764


Reported Activities of Sailor 3769 as Compared to Navy Standard Workweek
Hours Spent
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3769
NSW

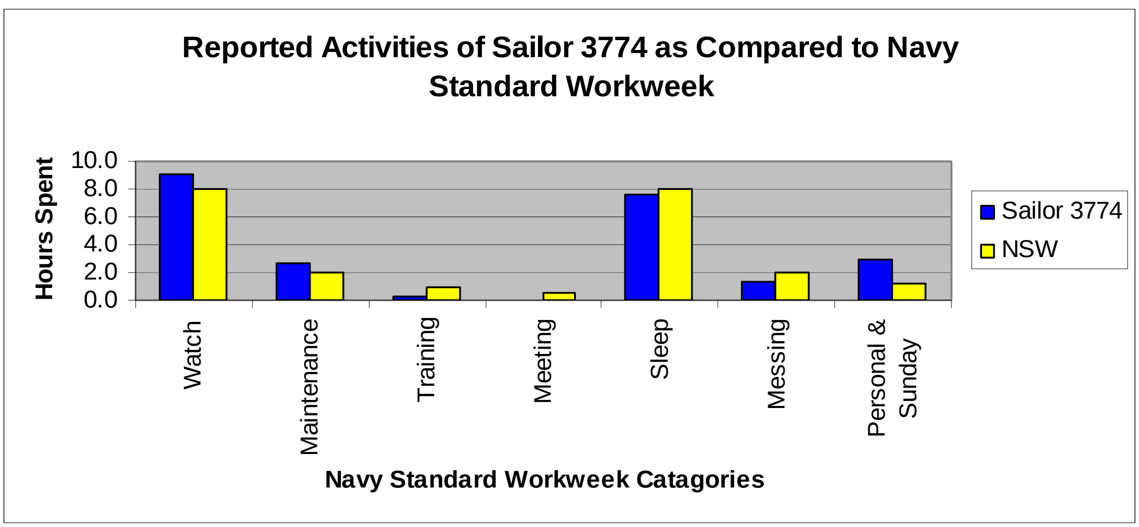
3769


Reported Activities of Sailor 3771 as Compared to Navy Standard Workweek
Hours Spent
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3771
NSW

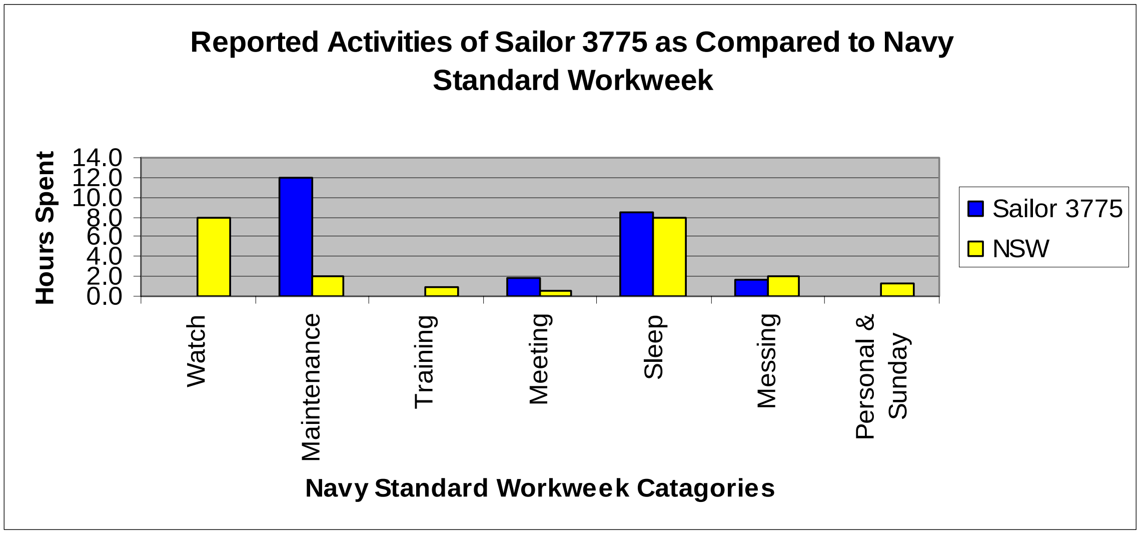
3771


Reported Activities of Sailor 3772 as Compared to Navy Standard Workweek
Hours Spent
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3772
NSW

3772

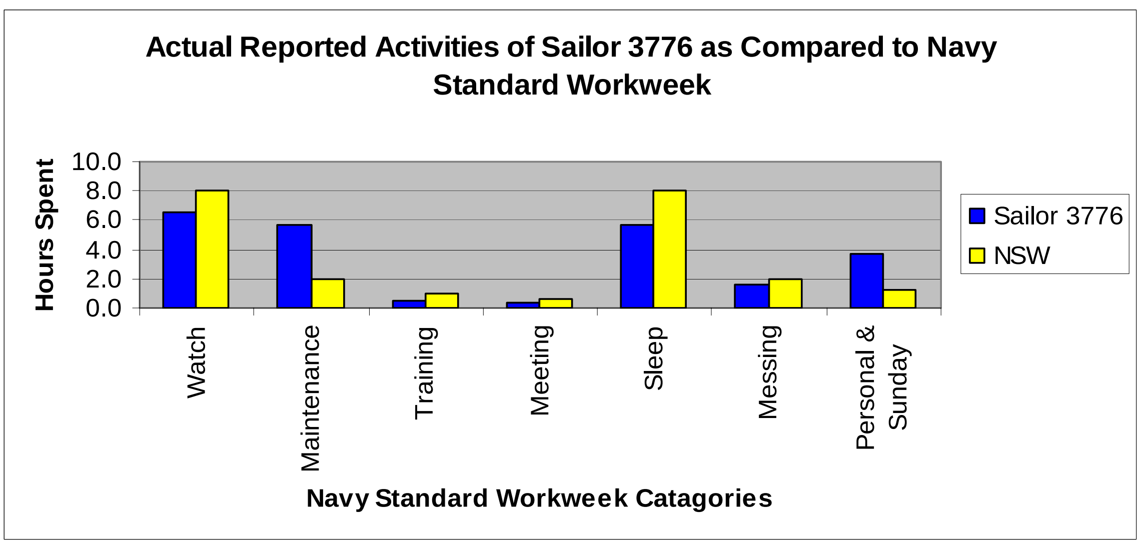

Reported Activities of Sailor 3774 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3774
NSW

3774



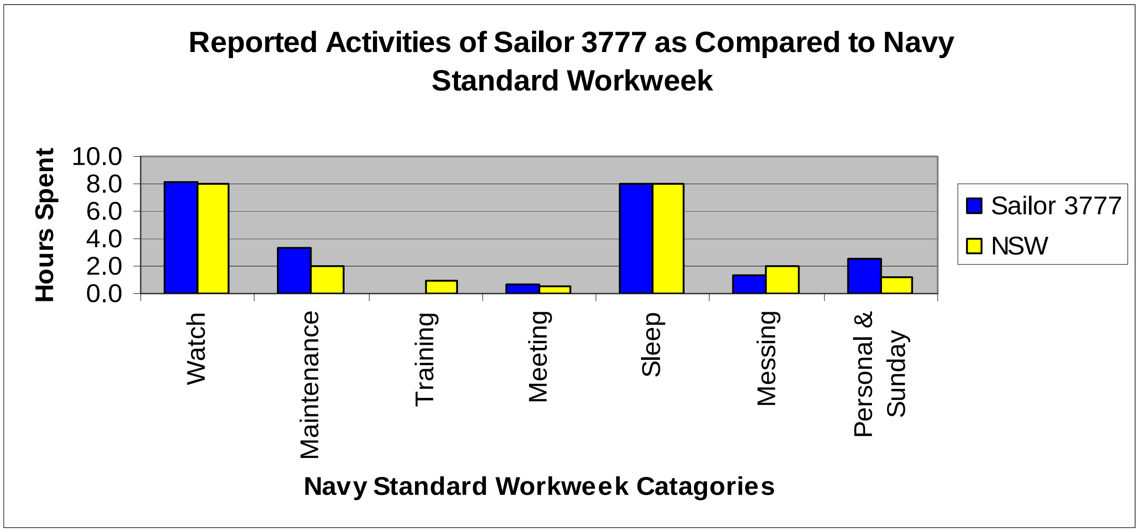
Reported Activities of Sailor 3775 as Compared to Navy Standard Workweek
Hours Spent
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3775
NSW

3775

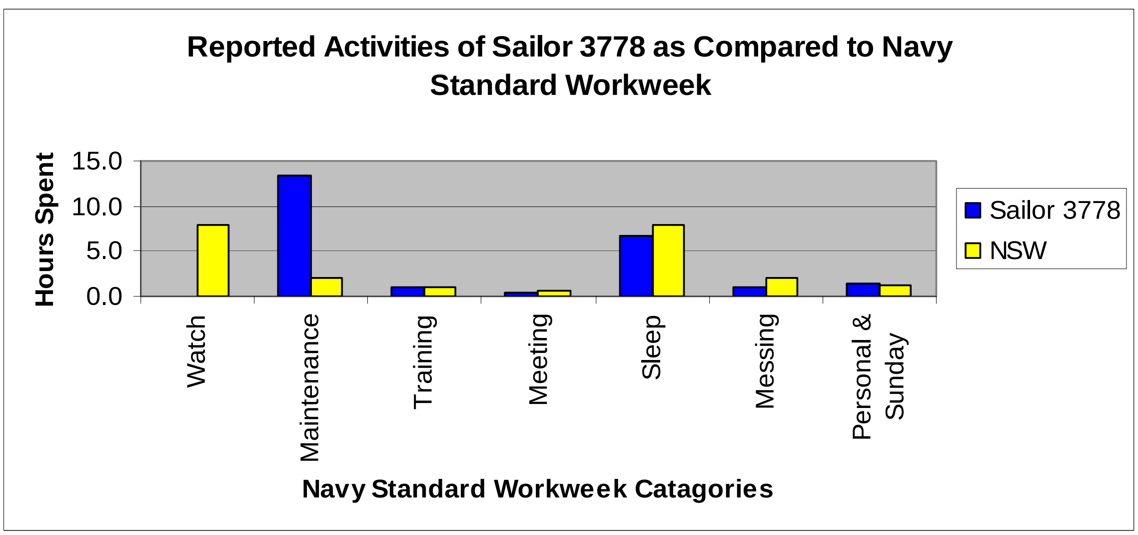


Actual Reported Activities of Sailor 3776 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3776
NSW

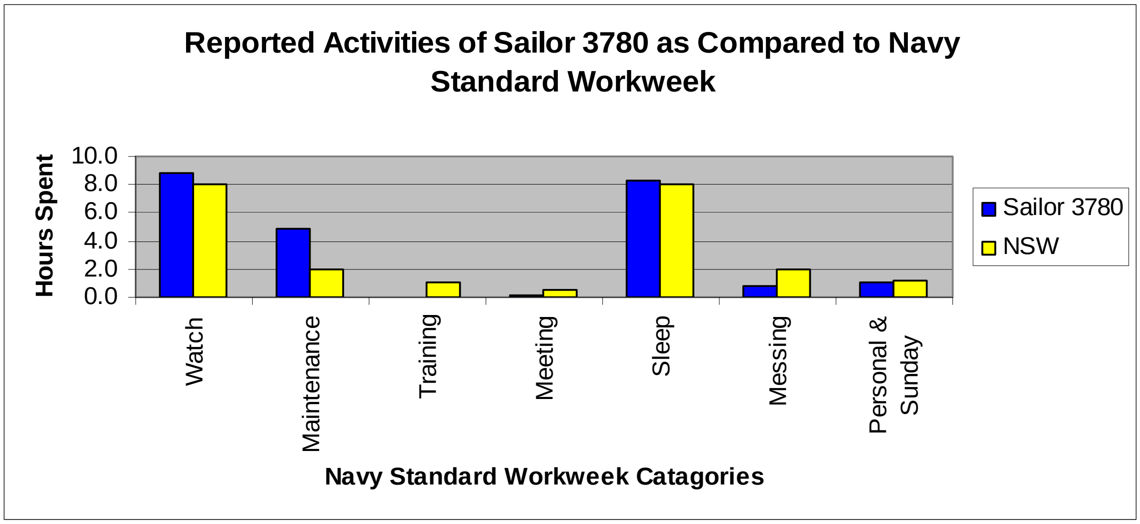
3776


Reported Activities of Sailor 3777 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3777
NSW

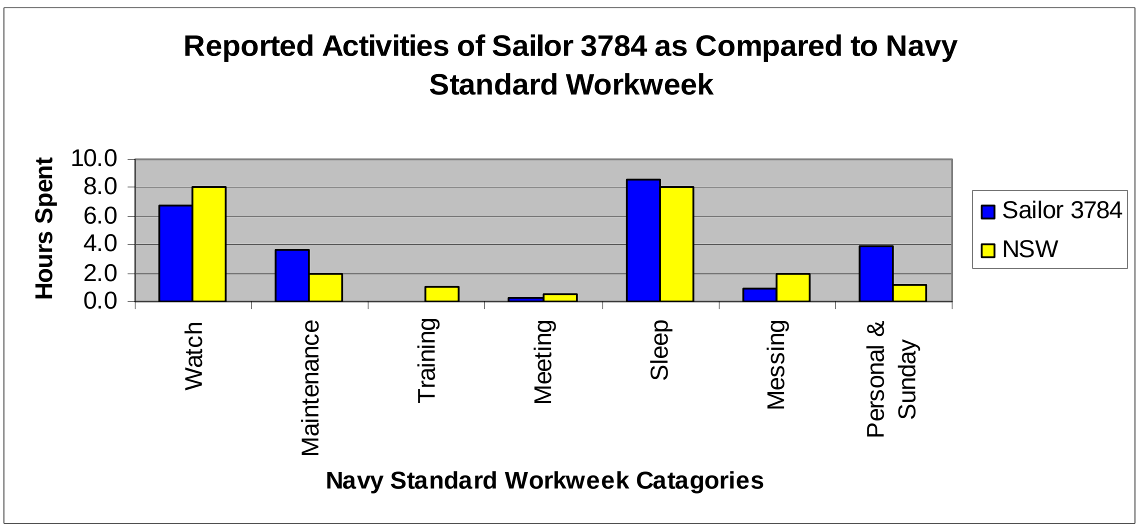
3777


Reported Activities of Sailor 3778 as Compared to Navy Standard Workweek
Hours Spent
15.0
10.0
5.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3778
NSW

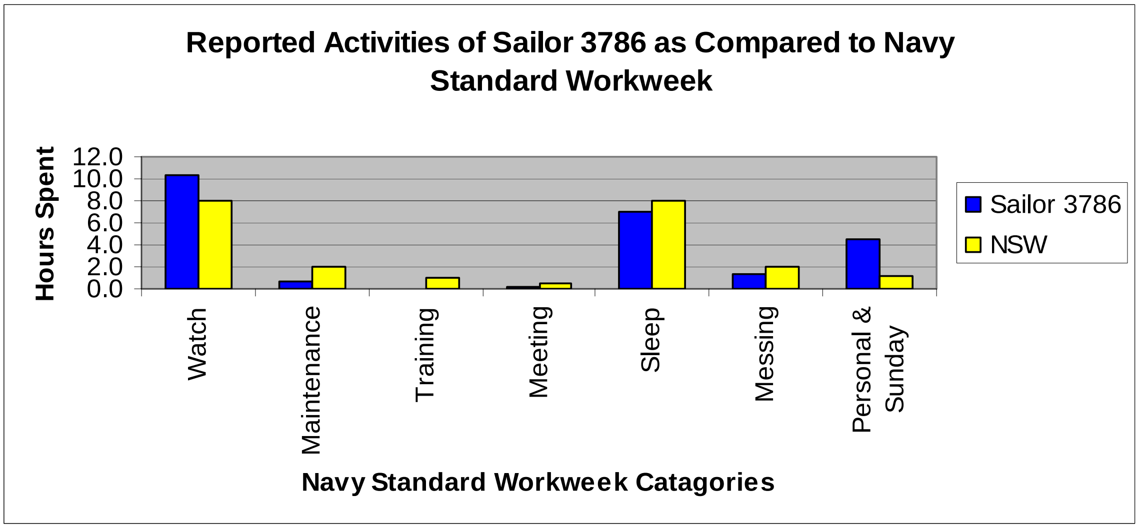
3778


Reported Activities of Sailor 3780 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3780
NSW

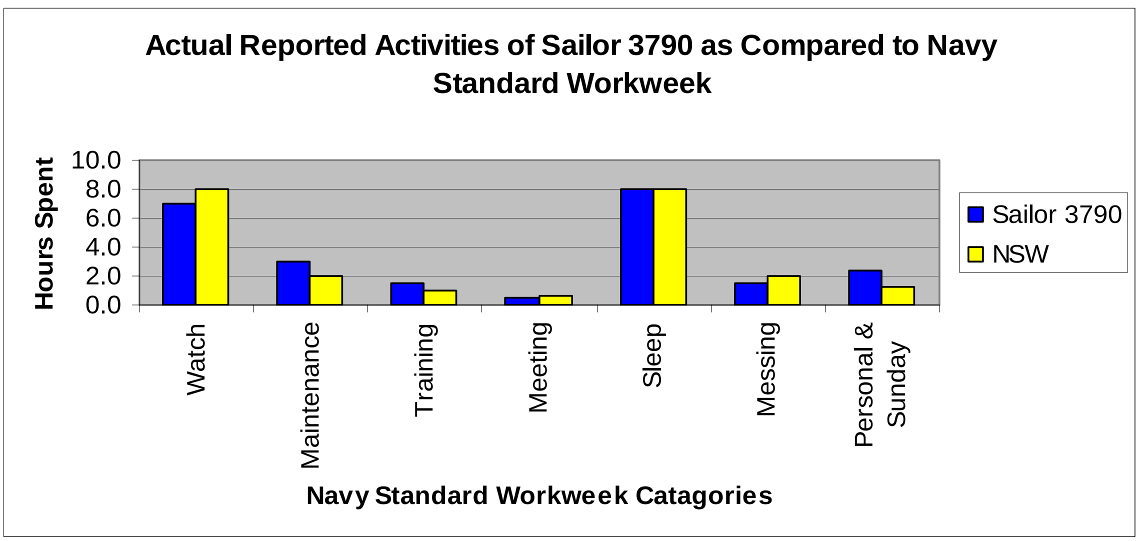
3780


Reported Activities of Sailor 3784 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3784
NSW

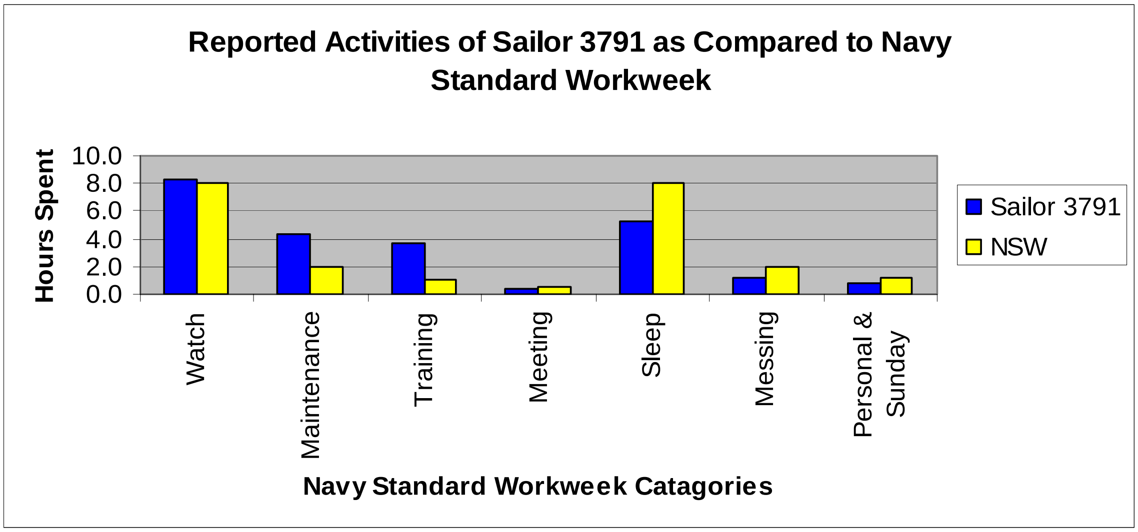
3784


Reported Activities of Sailor 3786 as Compared to Navy Standard Workweek
Hours Spent
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Sailor 3786
NSW
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories

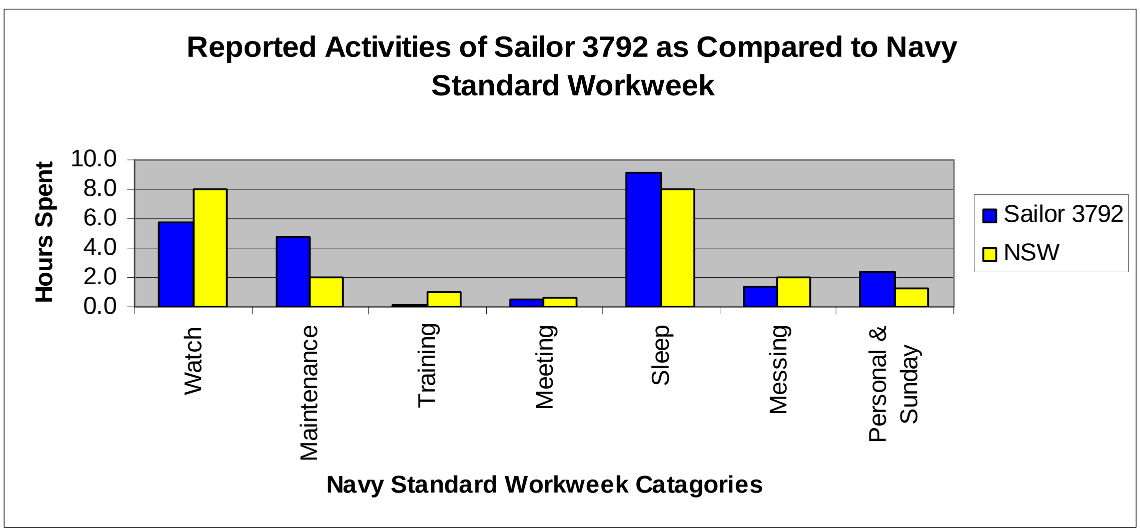
3786


Actual Reported Activities of Sailor 3790 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Sailor 3790
NSW
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories

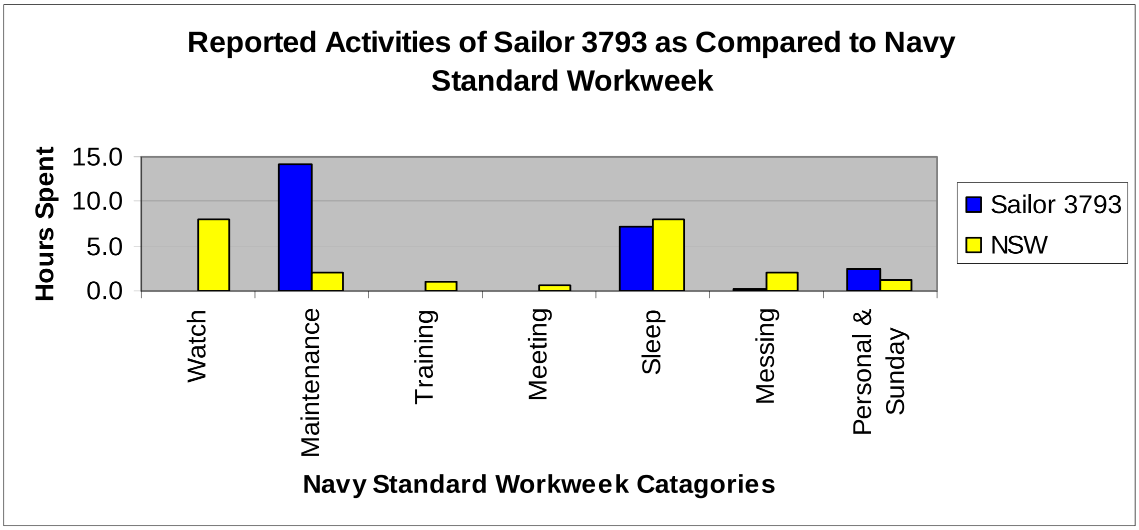
3790


Reported Activities of Sailor 3791 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3791
NSW

3791


Reported Activities of Sailor 3792 as Compared to Navy Standard Workweek
Hours Spent
10.0
8.0
6.0
4.0
2.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3792
NSW

3792

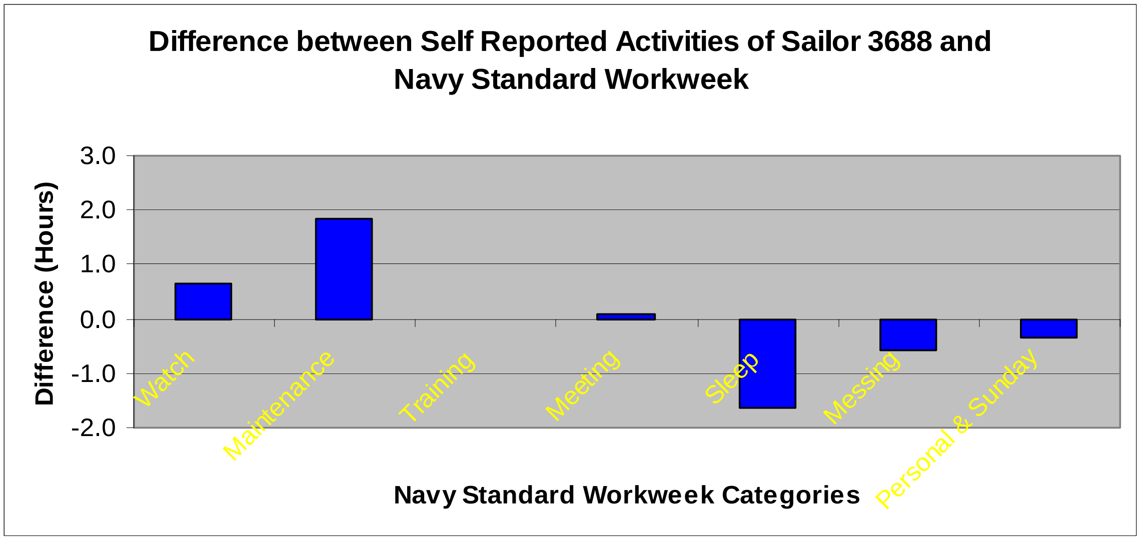


Reported Activities of Sailor 3793 as Compared to Navy Standard Workweek
Hours Spent
15.0
10.0
5.0
0.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Catagories
Sailor 3793
NSW

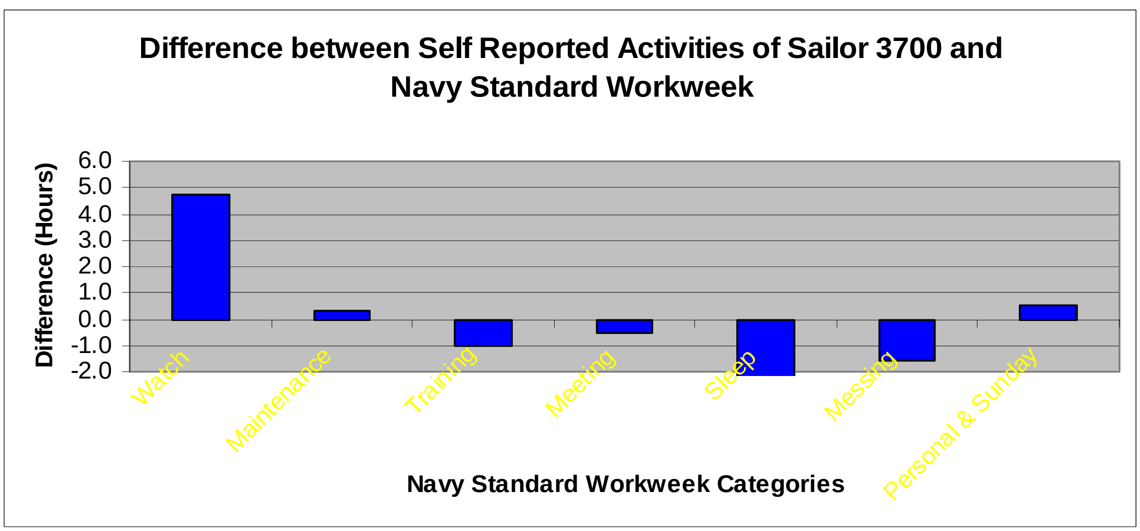
3793

THIS PAGE INTENTIONALLY LEFT BLANK

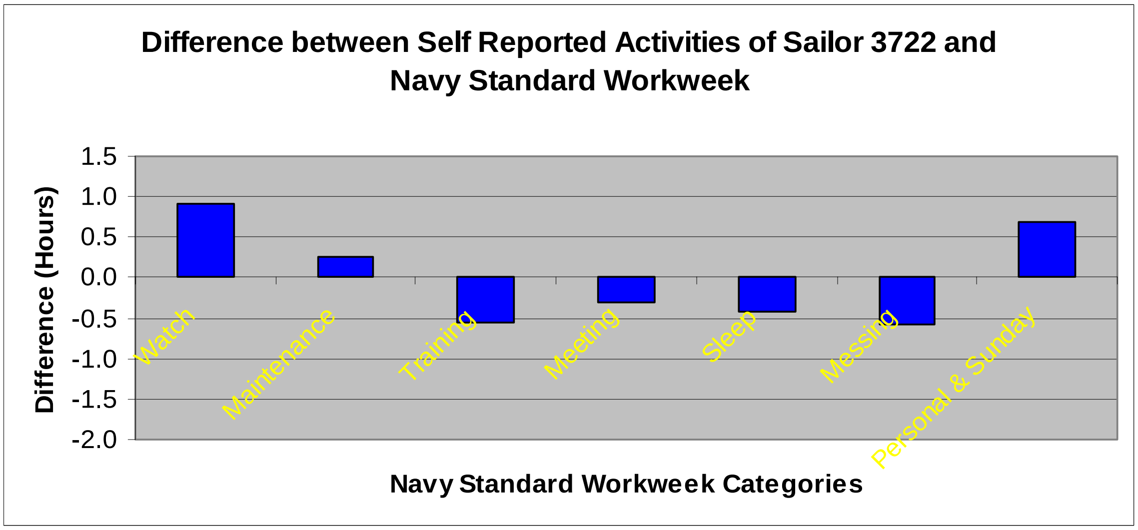
APPENDIX C. INDIVIDUAL SAILOR DIFFERENCE FROM THE NAVY STANDARD WORKWEEK



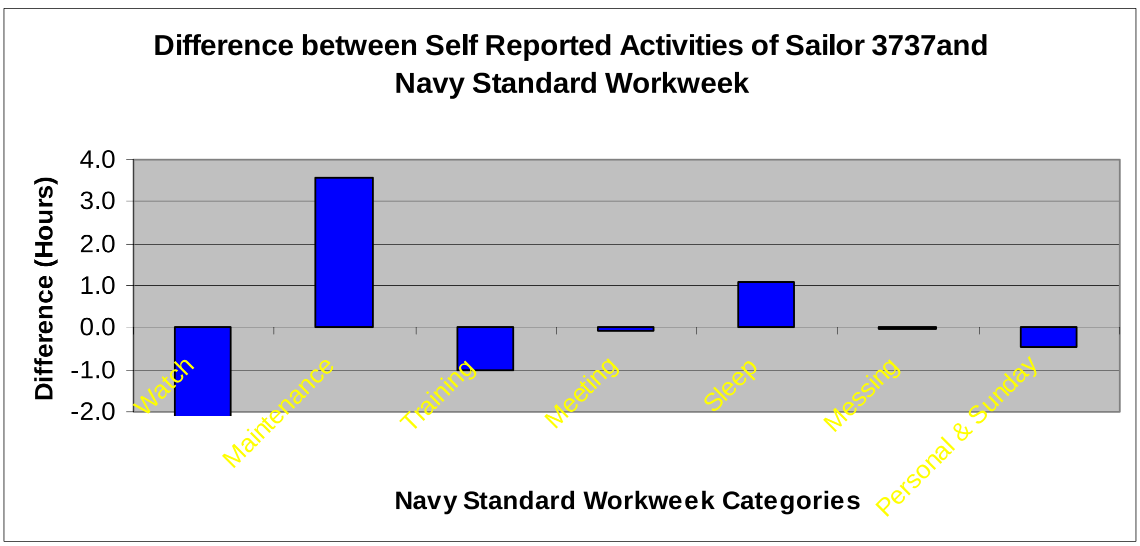
3688



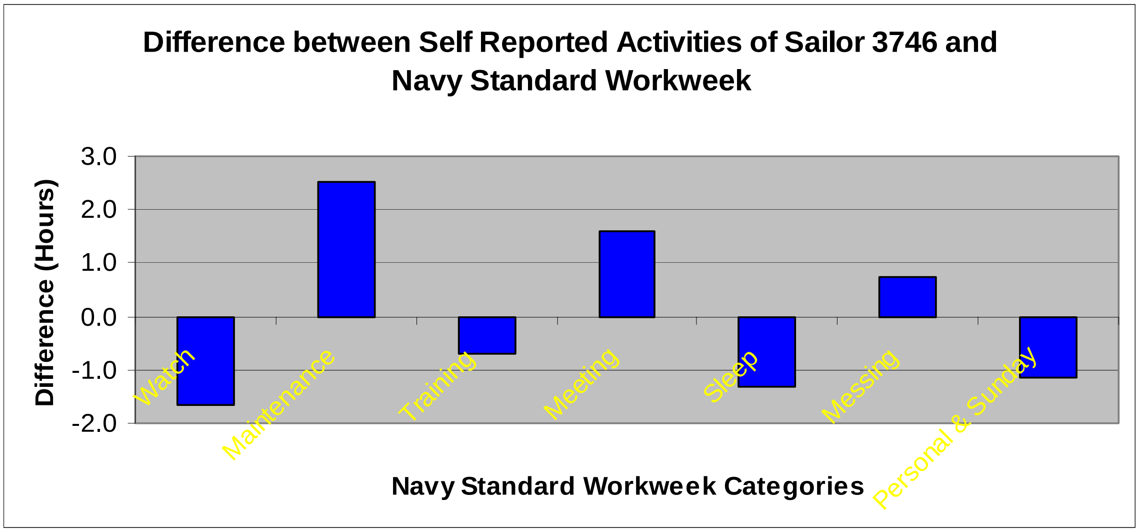
3700


Difference between Self Reported Activities of Sailor 3722 and Navy Standard Workweek
Difference (Hours)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

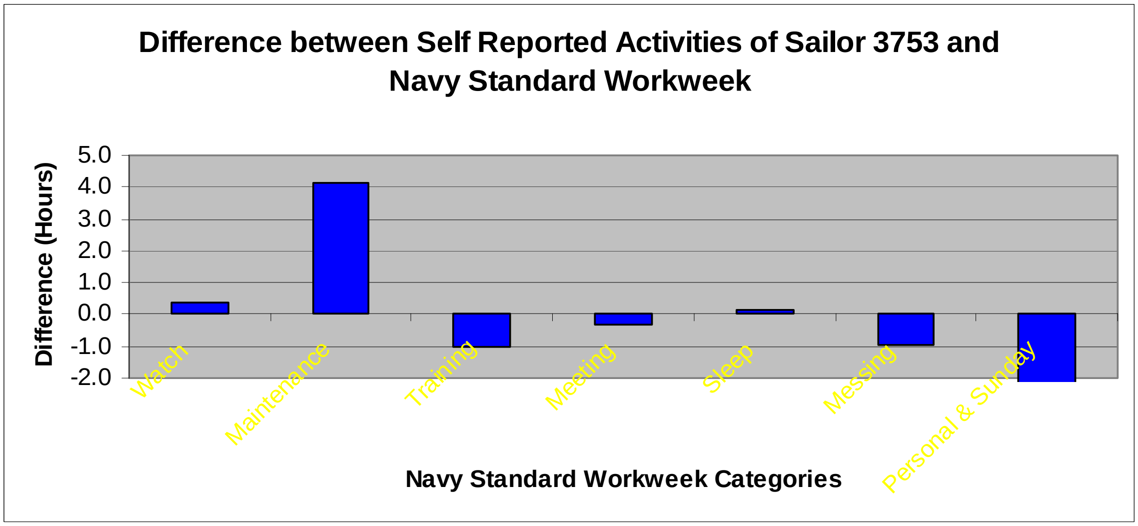
3722


Difference between Self Reported Activities of Sailor 3737and Navy Standard Workweek
Difference (Hours)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

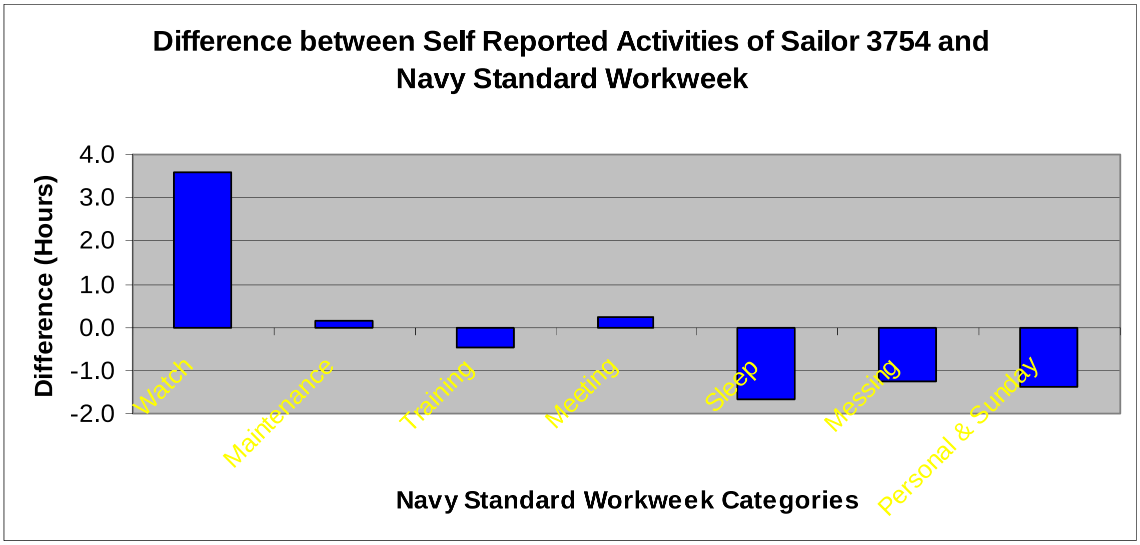
3737


Difference between Self Reported Activities of Sailor 3746 and
Navy Standard Workweek
Difference (Hours)
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

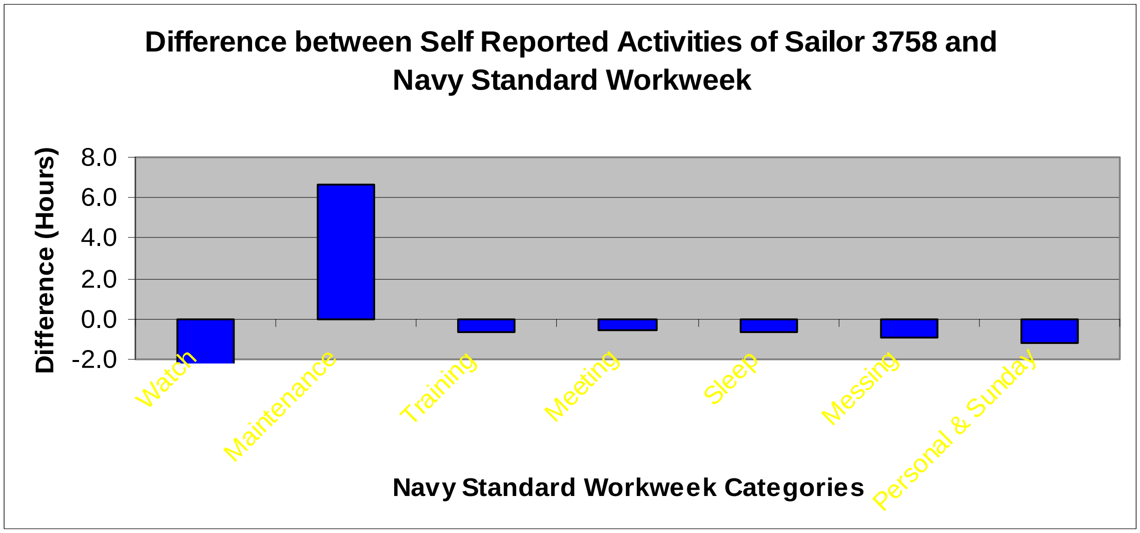
3746


Difference between Self Reported Activities of Sailor 3753 and
Navy Standard Workweek
Difference (Hours)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

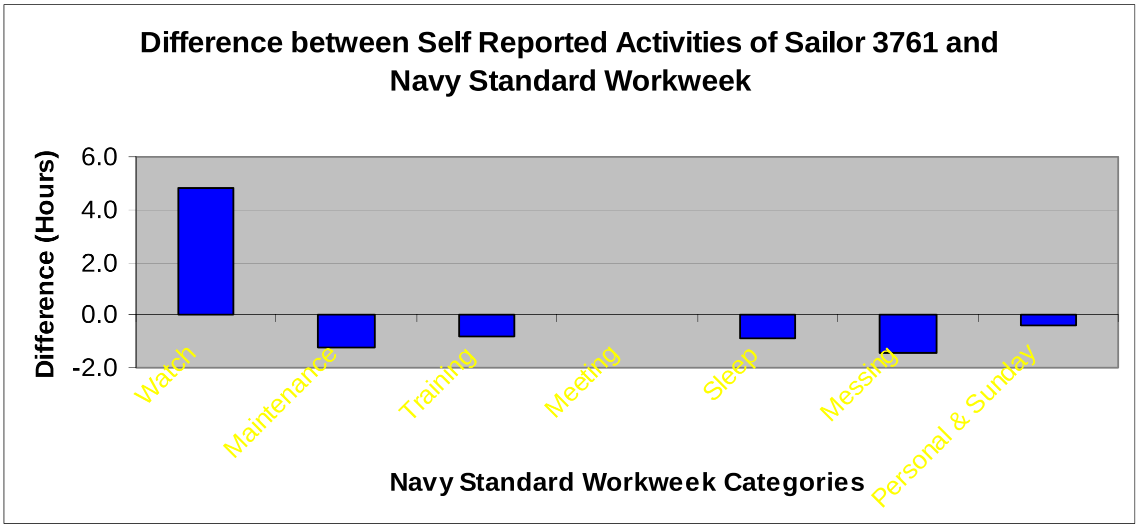
3753


Difference between Self Reported Activities of Sailor 3754 and Navy Standard Workweek
Difference (Hours)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

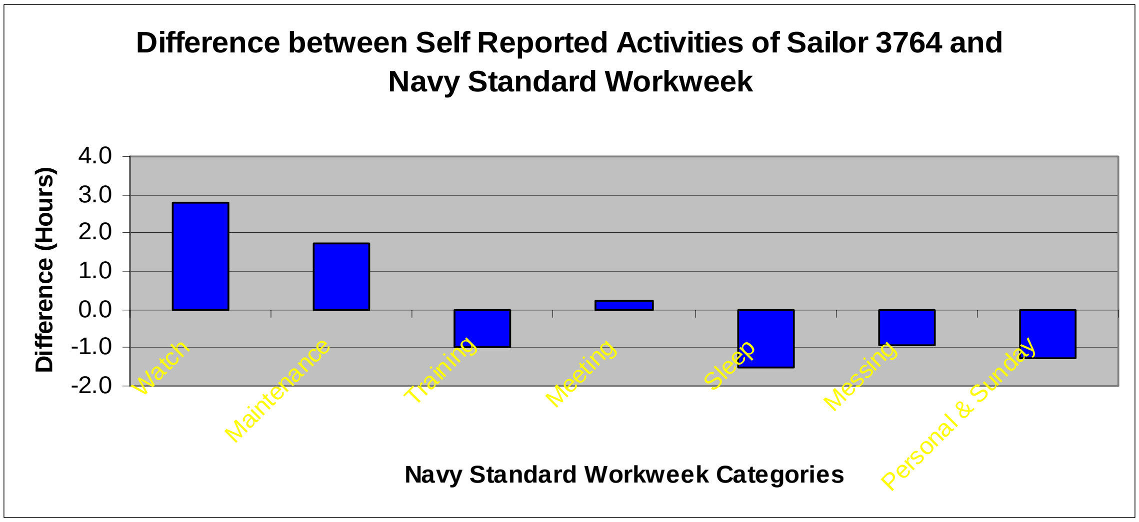
3754


Difference between Self Reported Activities of Sailor 3758 and Navy Standard Workweek
Difference (Hours)
8.0
6.0
4.0
2.0
0.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

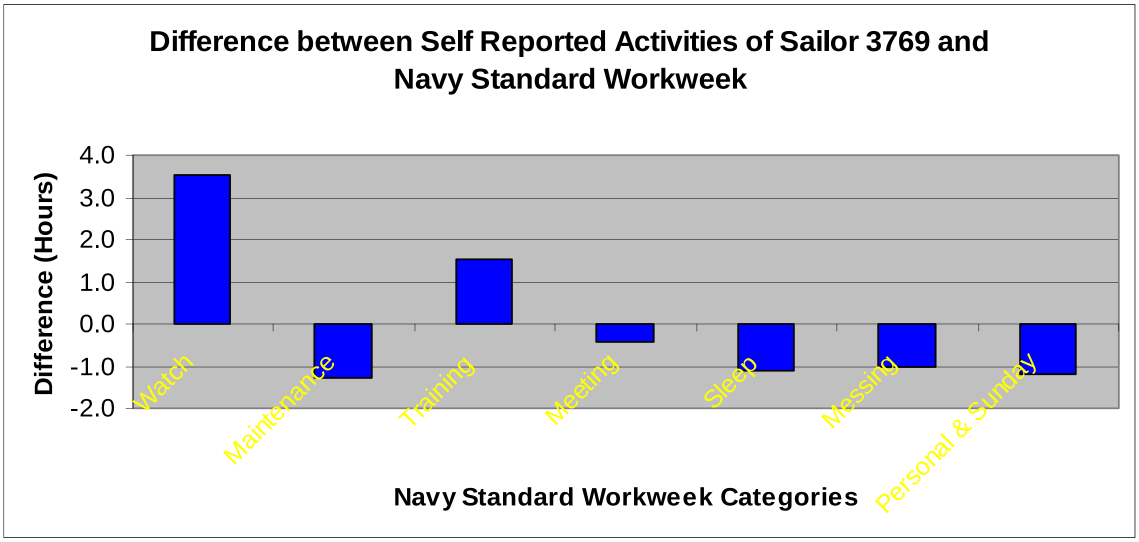
3758


Difference between Self Reported Activities of Sailor 3761 and Navy Standard Workweek
Difference (Hours)
6.0
4.0
2.0
0.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

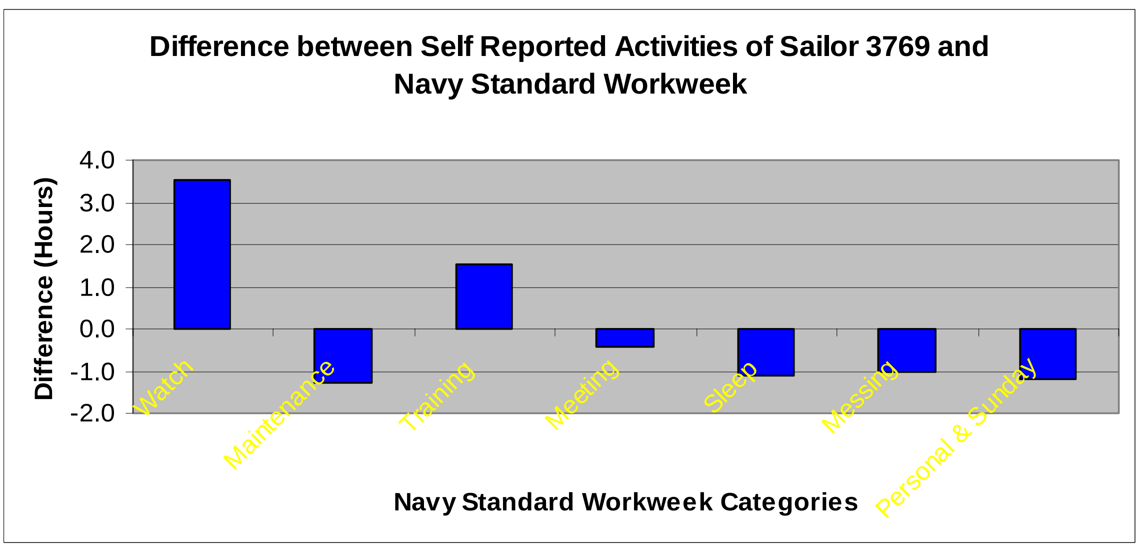
3761


Difference between Self Reported Activities of Sailor 3764 and Navy Standard Workweek
Difference (Hours)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

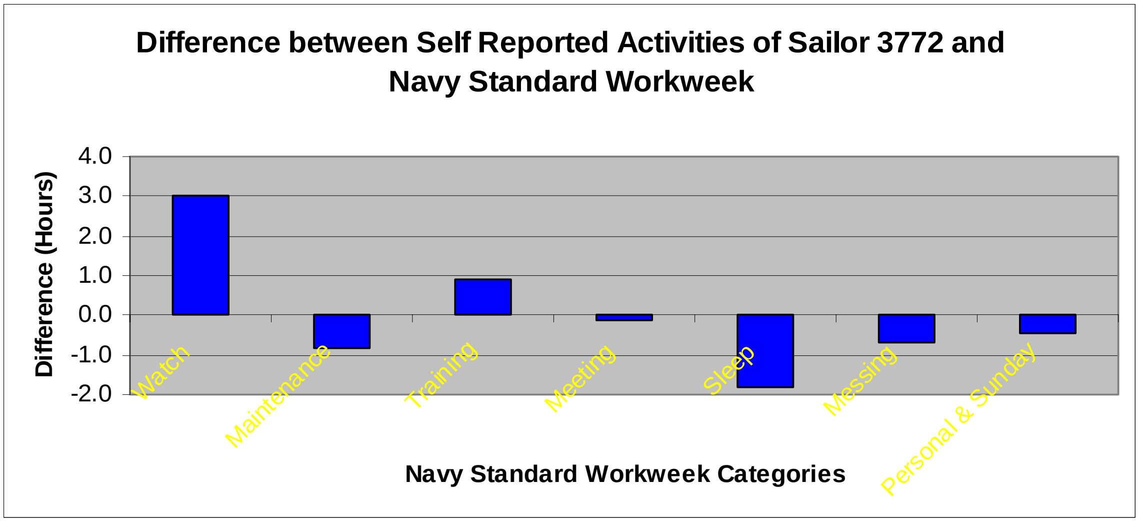
3764


Difference between Self Reported Activities of Sailor 3769 and Navy Standard Workweek
Difference (Hours)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3769

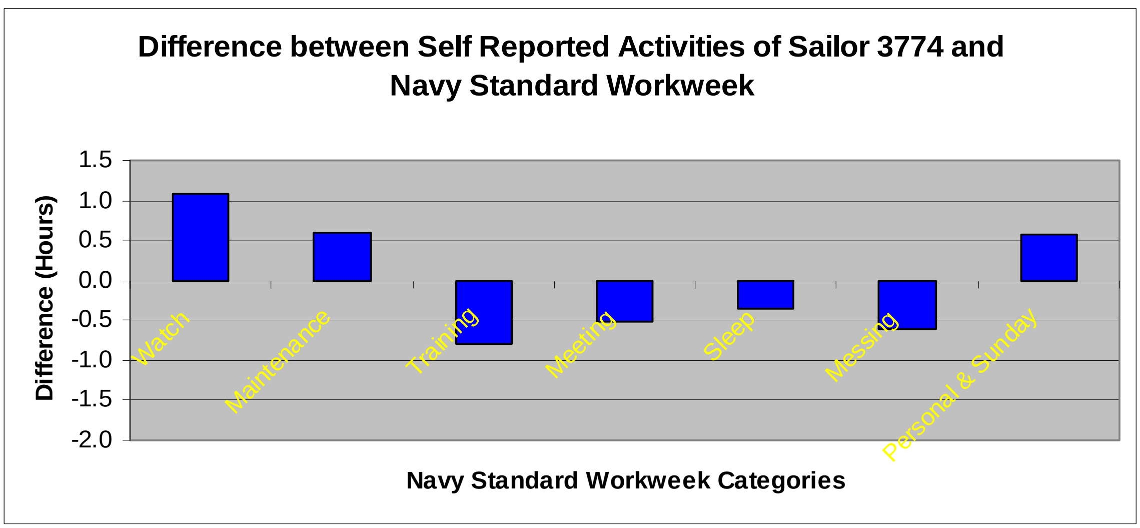

Difference between Self Reported Activities of Sailor 3769 and Navy Standard Workweek
Difference (Hours)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3771



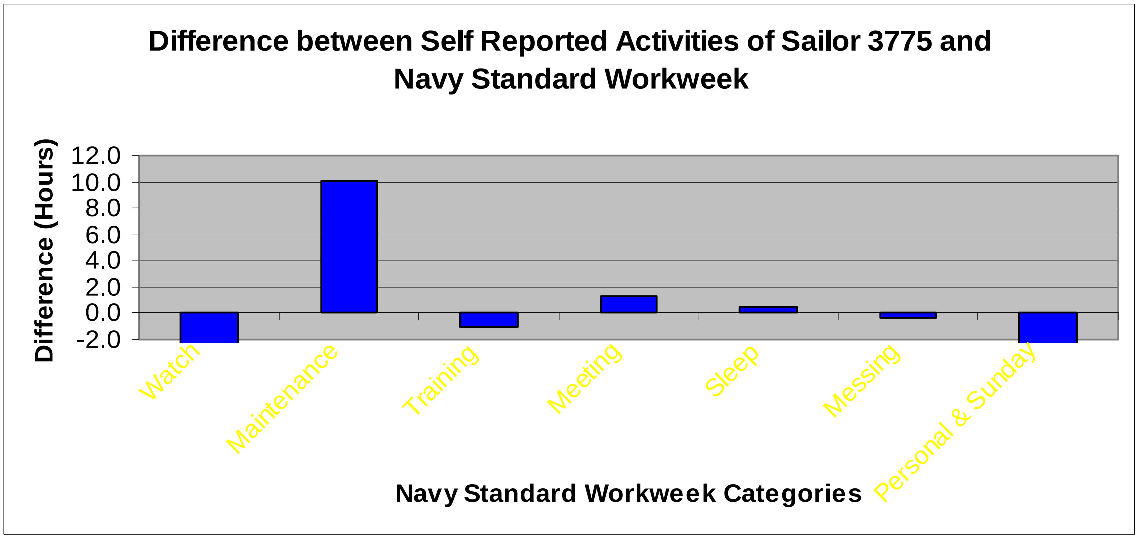
Difference between Self Reported Activities of Sailor 3772 and Navy Standard Workweek
Difference (Hours)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3772



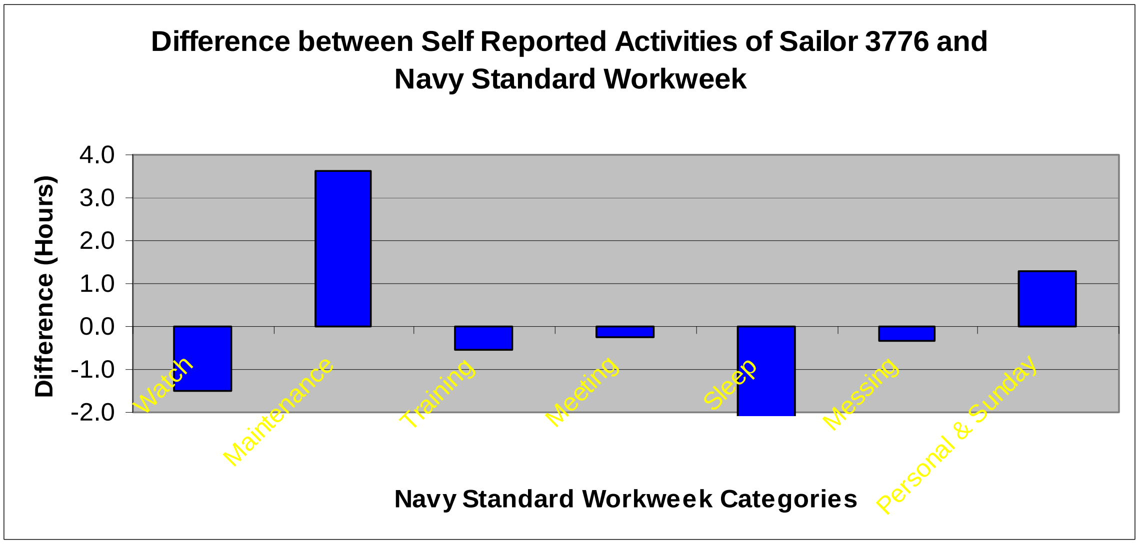
Difference between Self Reported Activities of Sailor 3774 and Navy Standard Workweek
Difference (Hours)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3774



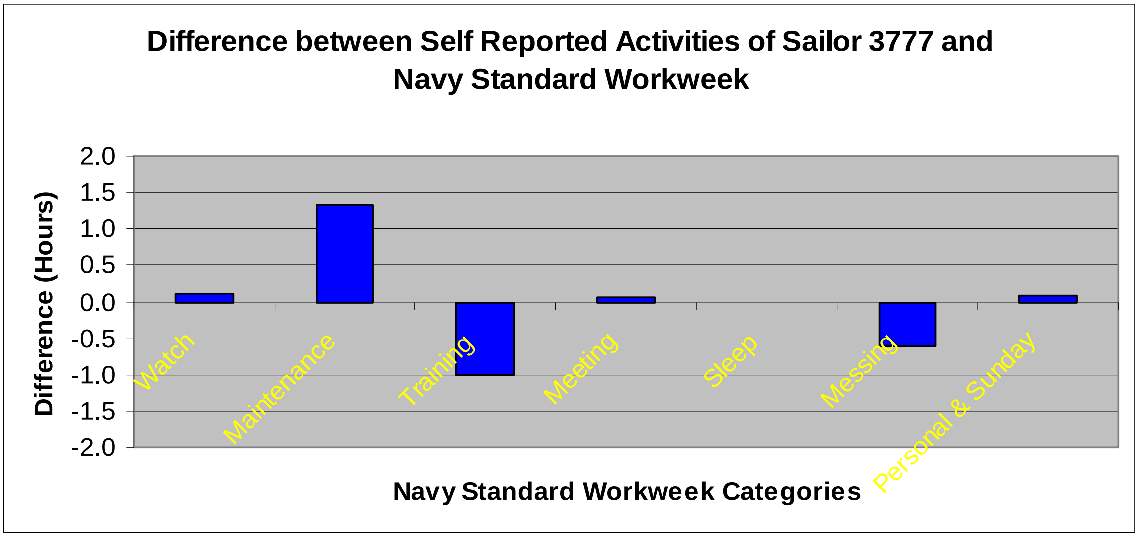
Difference between Self Reported Activities of Sailor 3775 and
Navy Standard Workweek
Difference (Hours)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3775

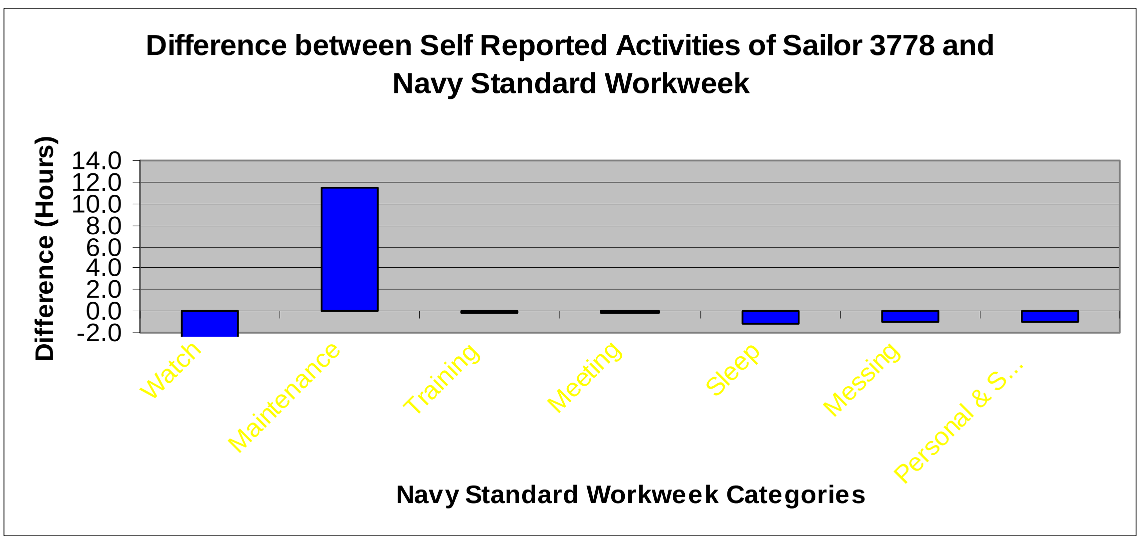


Difference between Self Reported Activities of Sailor 3776 and
Navy Standard Workweek
Difference (Hours)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

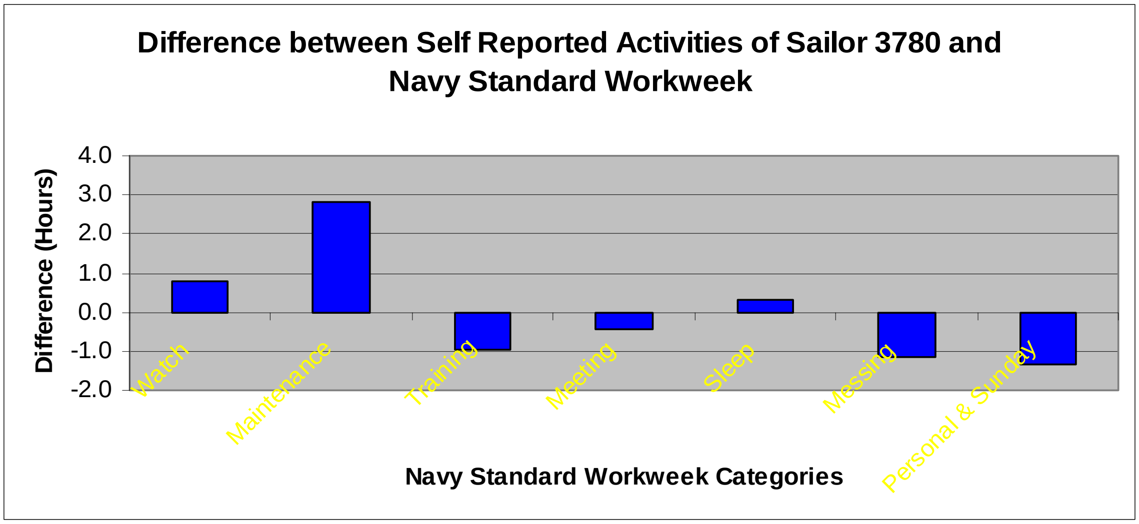
3776


Difference between Self Reported Activities of Sailor 3777 and Navy Standard Workweek
Difference (Hours)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

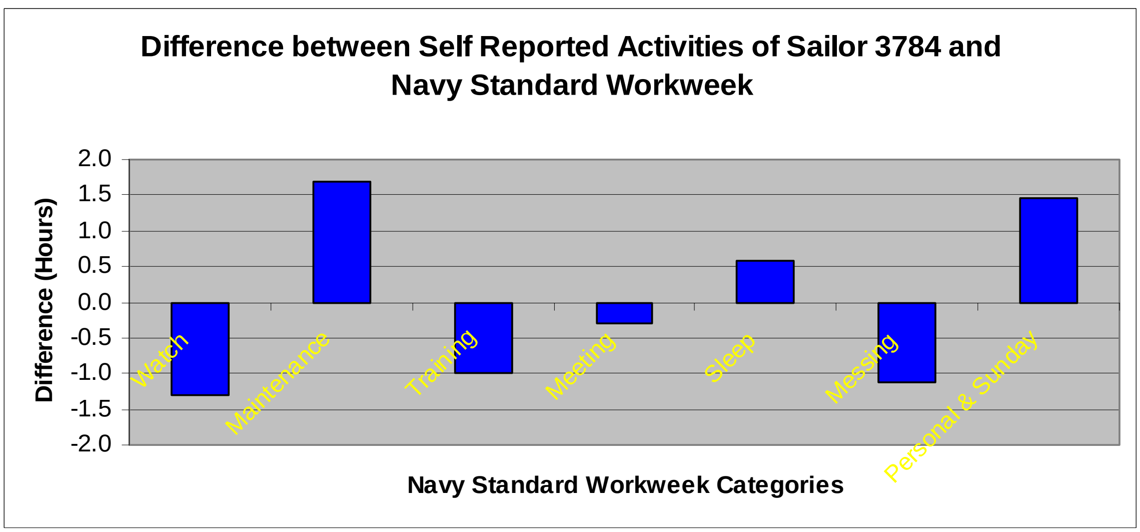
3777


Difference between Self Reported Activities of Sailor 3778 and Navy Standard Workweek
Difference (Hours)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & S...
Navy Standard Workweek Categories

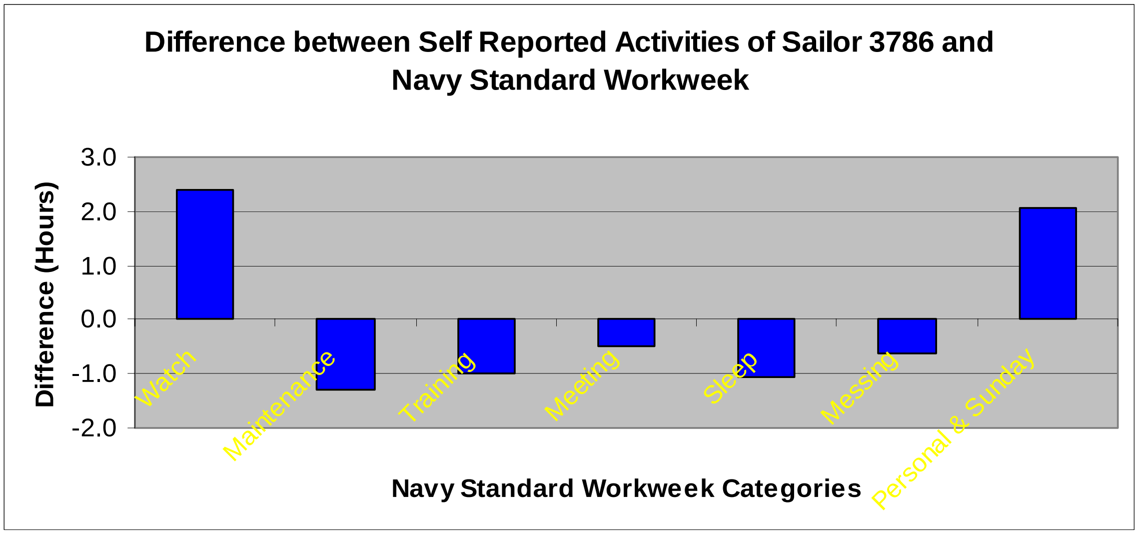
3778


Difference between Self Reported Activities of Sailor 3780 and Navy Standard Workweek
Difference (Hours)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3780

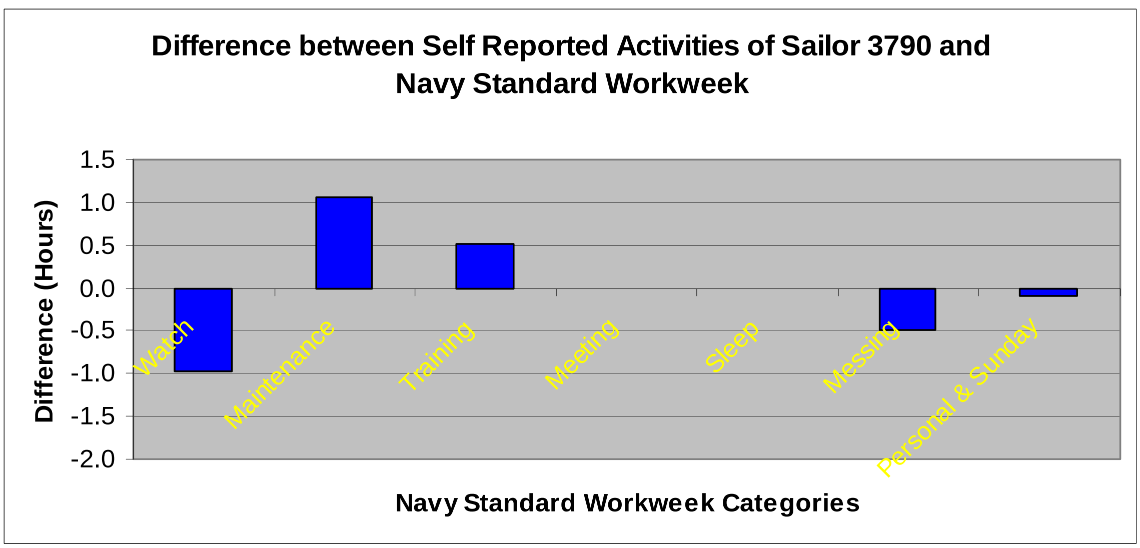

Difference between Self Reported Activities of Sailor 3784 and Navy Standard Workweek
Difference (Hours)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3784



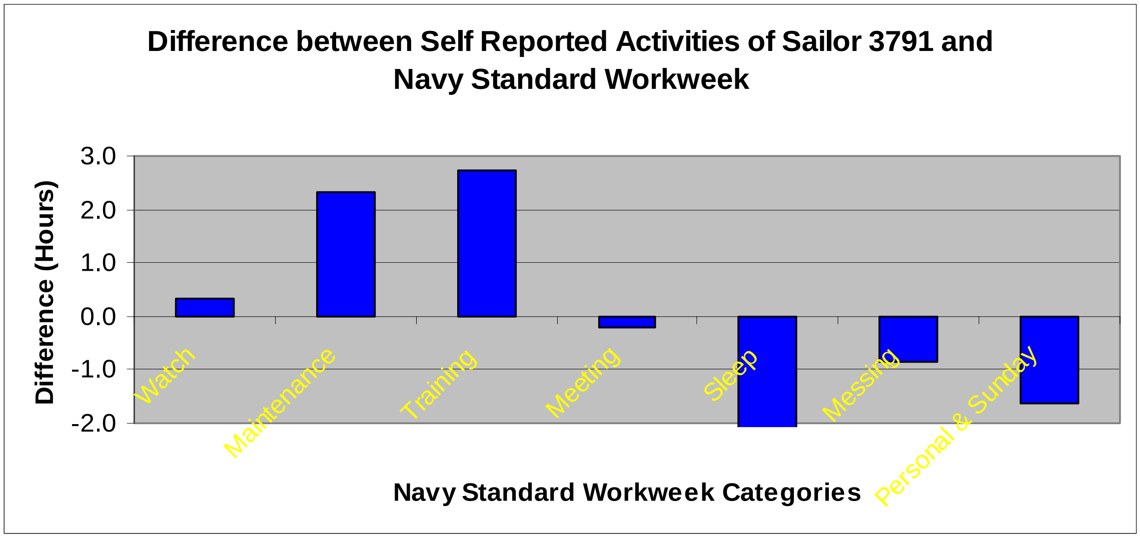
Difference between Self Reported Activities of Sailor 3786 and Navy Standard Workweek
Difference (Hours)
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3786

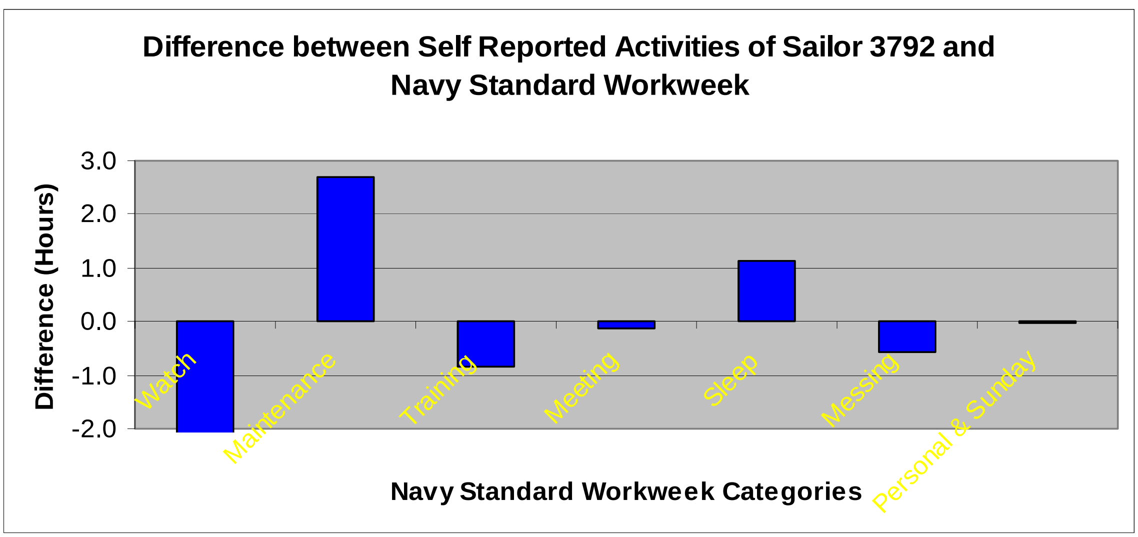


Difference between Self Reported Activities of Sailor 3790 and Navy Standard Workweek
Difference (Hours)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

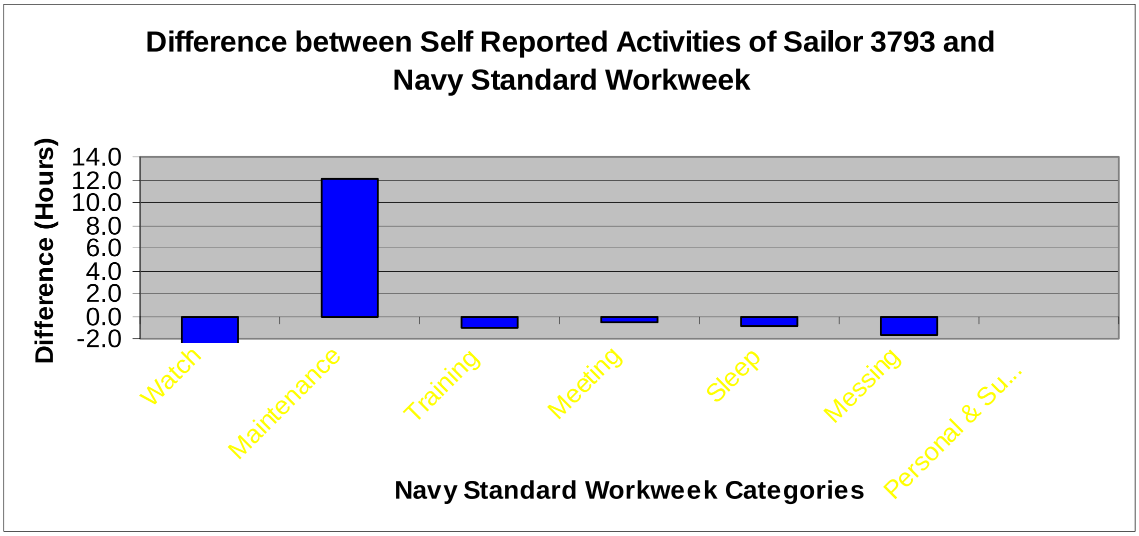
3790


Difference between Self Reported Activities of Sailor 3791 and Navy Standard Workweek
Difference (Hours)
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3791


Difference between Self Reported Activities of Sailor 3792 and Navy Standard Workweek
Difference (Hours)
3.0
2.0
1.0
0.0
-1.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

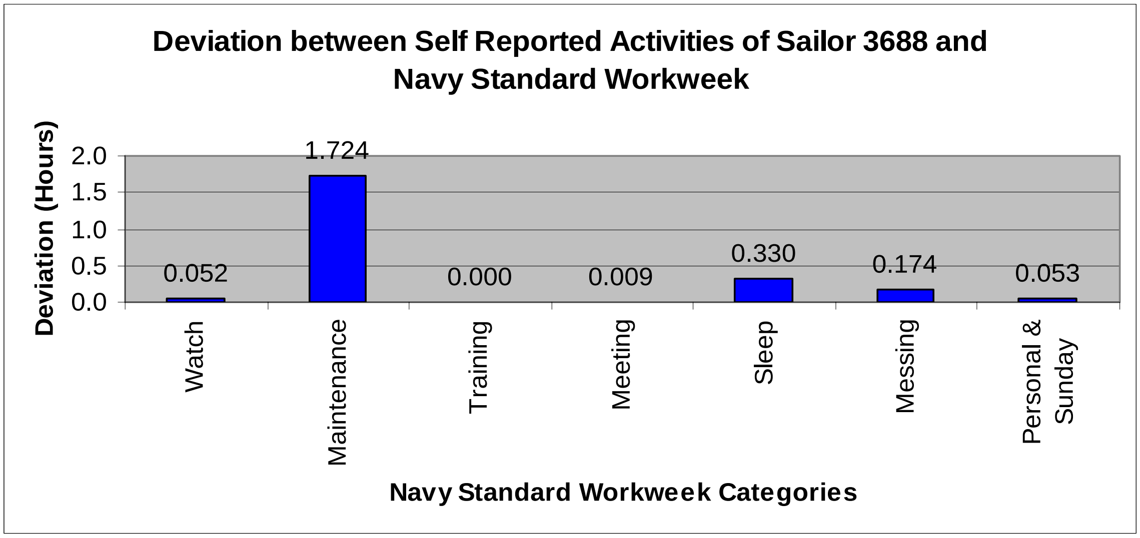
3792


Difference between Self Reported Activities of Sailor 3793 and Navy Standard Workweek
Difference (Hours)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Su...
Navy Standard Workweek Categories

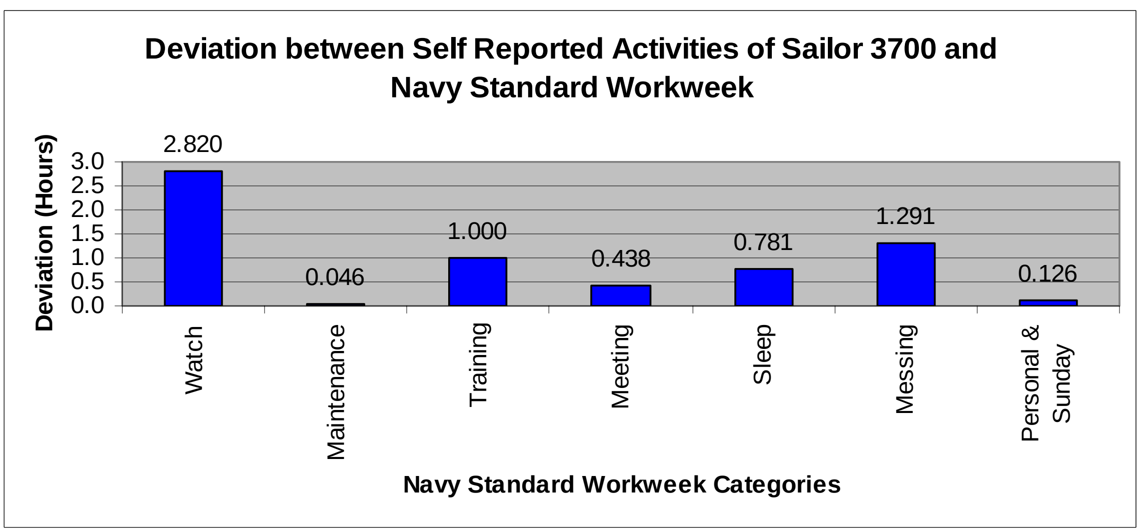
3793

THIS PAGE INTENTIONALLY LEFT BLANK

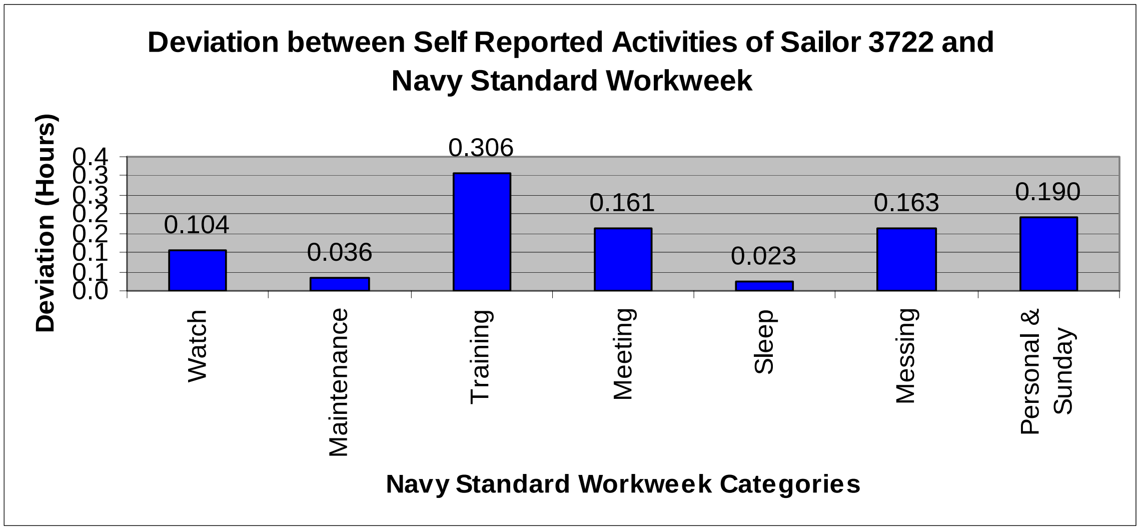
APPENDIX D. INDIVIDUAL SAILOR DEVIATION FROM NAVY STANDARD WORKWEEK



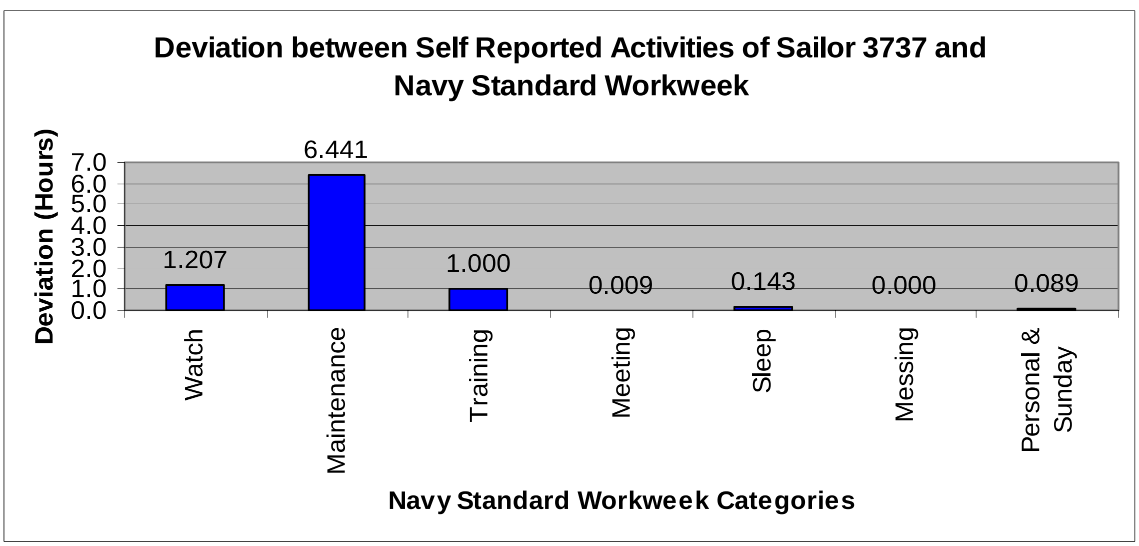
3688



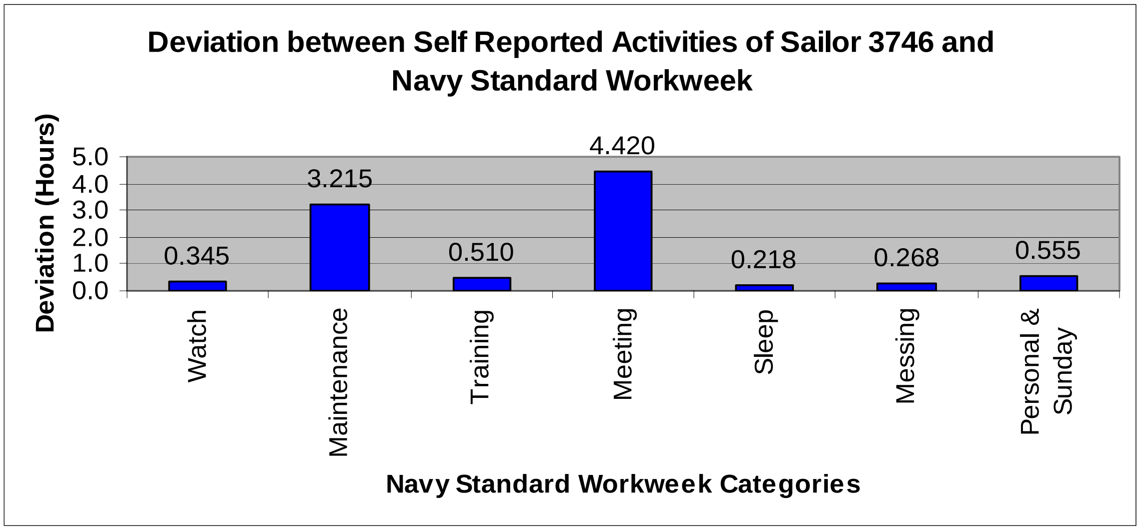
3700


Deviation between Self Reported Activities of Sailor 3722 and Navy Standard Workweek
Deviation (Hours)
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
0.104
0.036
0.306
0.161
0.023
0.163
0.190
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

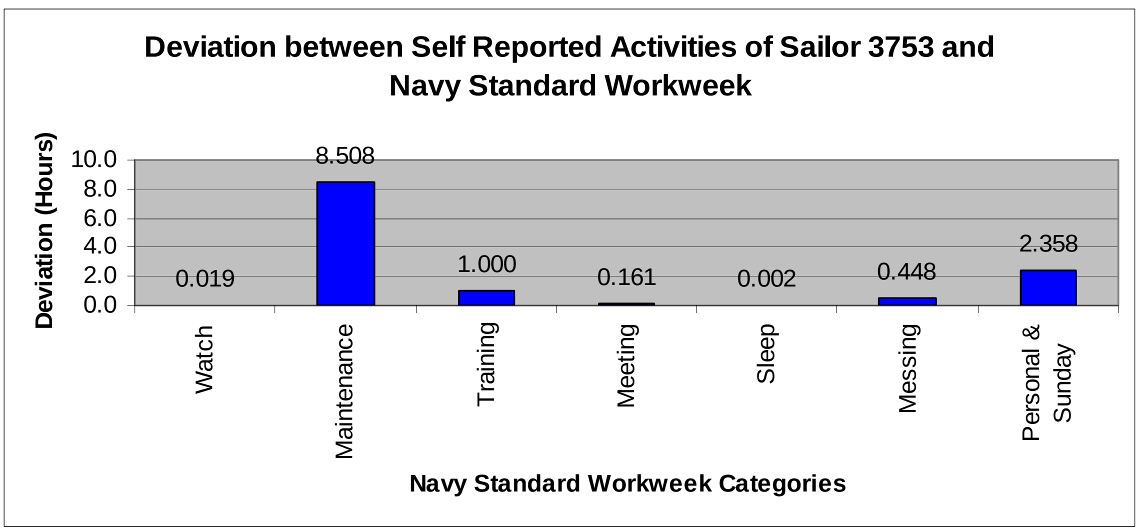
3722


Deviation between Self Reported Activities of Sailor 3737 and Navy Standard Workweek
Deviation (Hours)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1.207
6.441
1.000
0.009
0.143
0.000
0.089
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

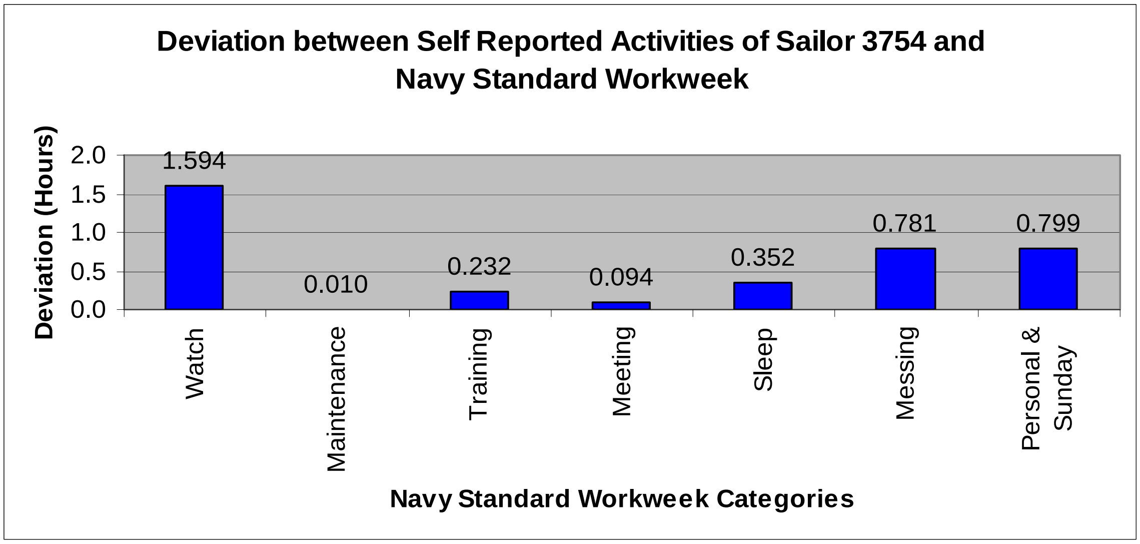
3737


Deviation between Self Reported Activities of Sailor 3746 and Navy Standard Workweek
Deviation (Hours)
5.0
4.0
3.0
2.0
1.0
0.0
0.345
3.215
0.510
4.420
0.218
0.268
0.555
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

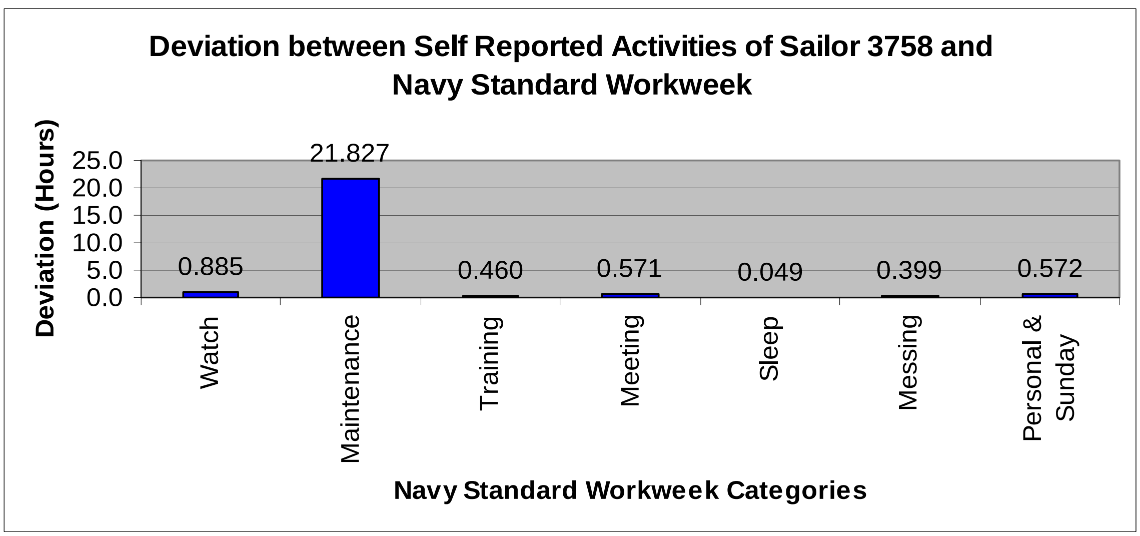
3746


Deviation between Self Reported Activities of Sailor 3753 and Navy Standard Workweek
Deviation (Hours)
10.0
8.0
6.0
4.0
2.0
0.0
0.019
8.508
1.000
0.161
0.002
0.448
2.358
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

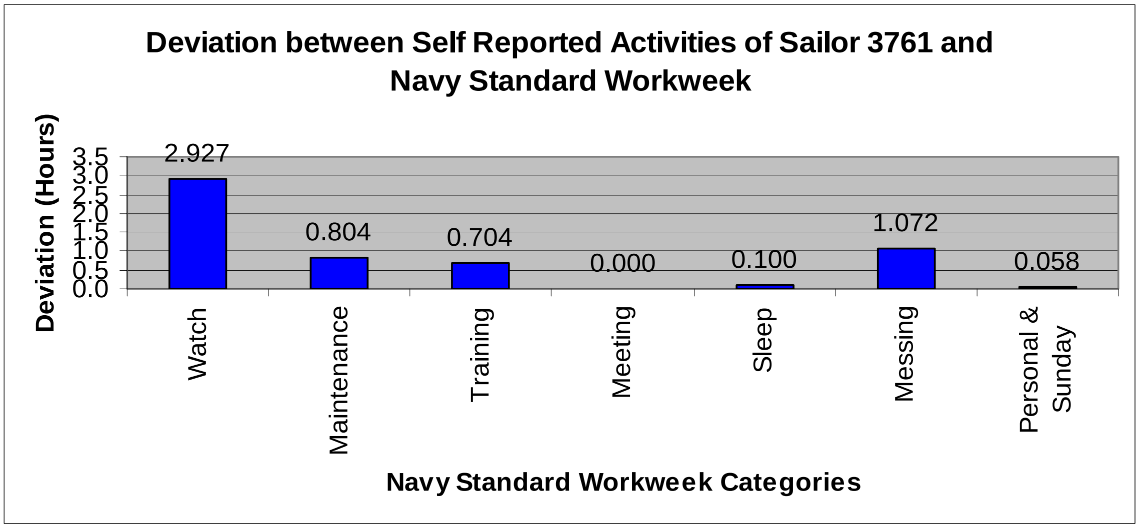
3753


Deviation between Self Reported Activities of Sailor 3754 and Navy Standard Workweek
Deviation (Hours)
2.0
1.5
1.0
0.5
0.0
1.594
0.010
0.232
0.094
0.352
0.781
0.799
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

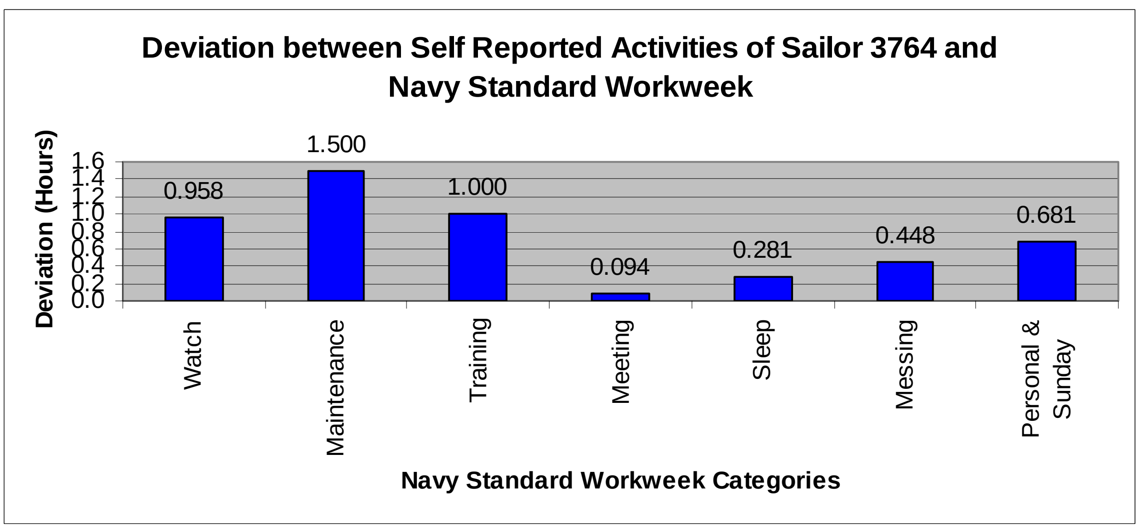
3754


Deviation between Self Reported Activities of Sailor 3758 and Navy Standard Workweek
Deviation (Hours)
25.0
20.0
15.0
10.0
5.0
0.0
0.885
21.827
0.460
0.571
0.049
0.399
0.572
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

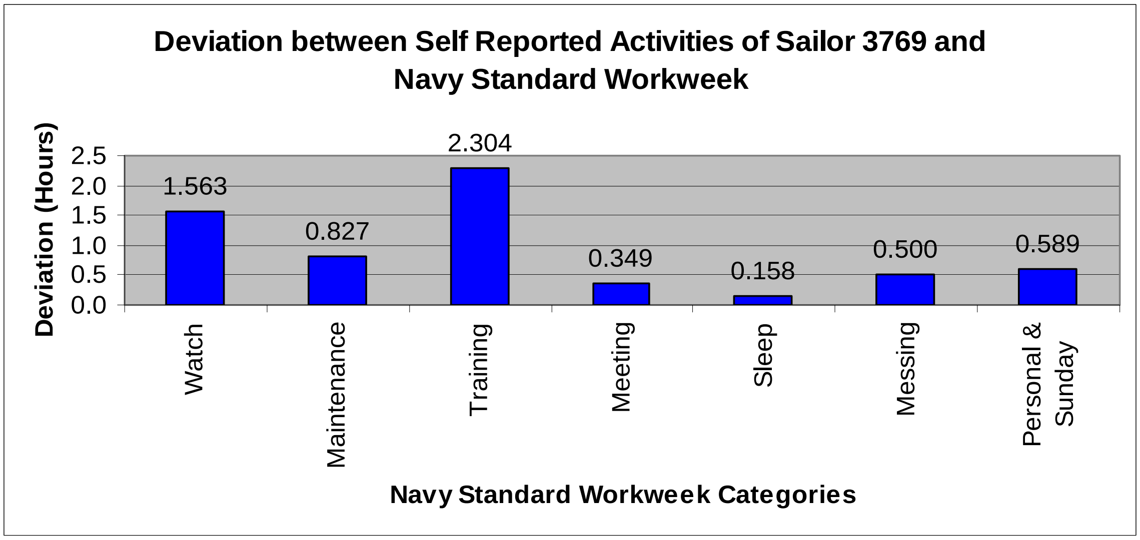
3758


Deviation between Self Reported Activities of Sailor 3761 and Navy Standard Workweek
Deviation (Hours)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.927
0.804
0.704
0.000
0.100
1.072
0.058
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

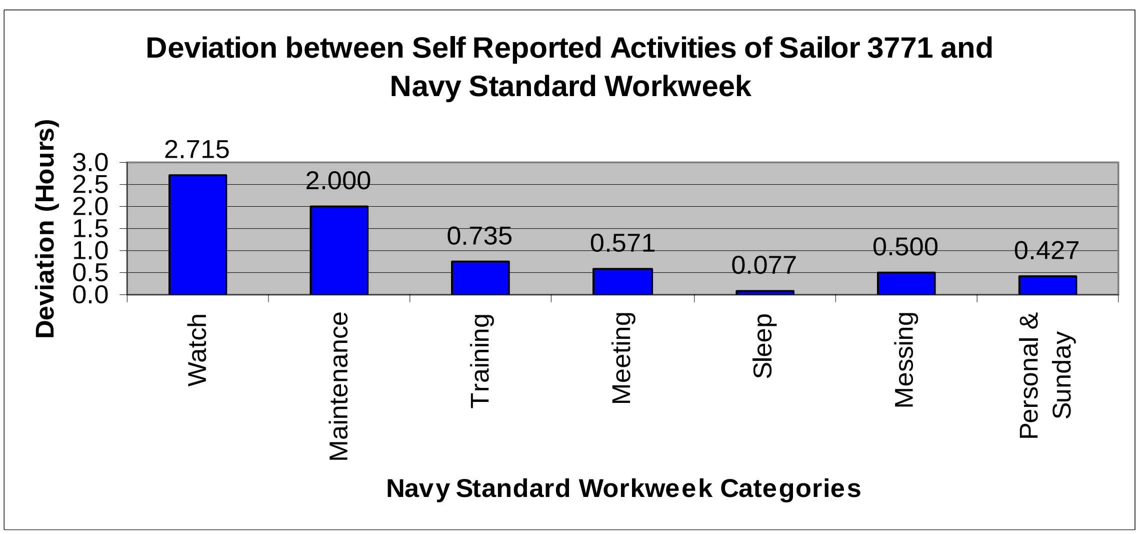
3761


Deviation between Self Reported Activities of Sailor 3764 and Navy Standard Workweek
Deviation (Hours)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.958
1.500
1.000
0.094
0.281
0.448
0.681
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

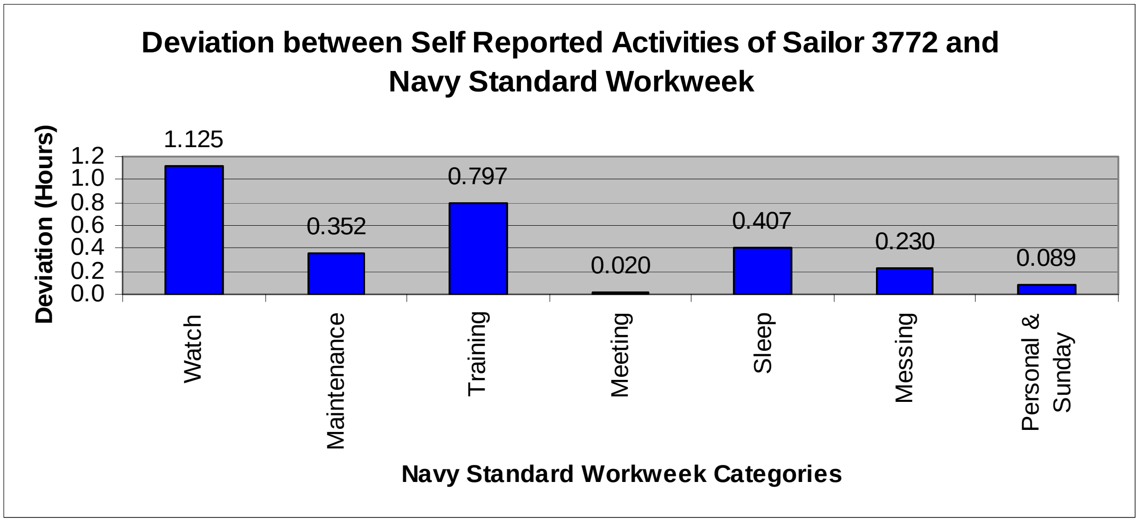
3764


Deviation between Self Reported Activities of Sailor 3769 and Navy Standard Workweek
Deviation (Hours)
2.5
2.0
1.5
1.0
0.5
0.0
1.563
0.827
2.304
0.349
0.158
0.500
0.589
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

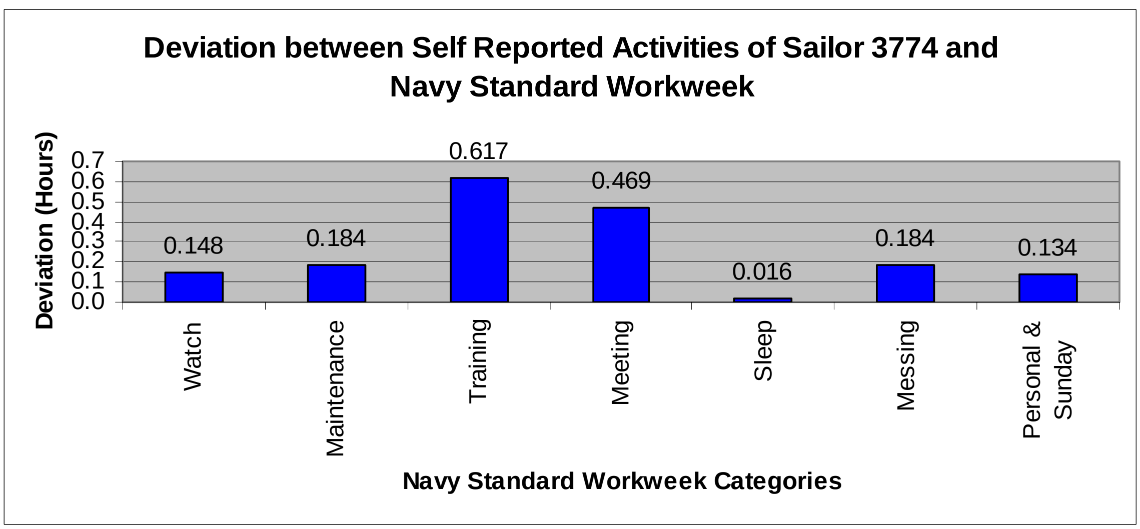
3769


Deviation between Self Reported Activities of Sailor 3771 and Navy Standard Workweek
Deviation (Hours)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.715
2.000
0.735
0.571
0.077
0.500
0.427
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

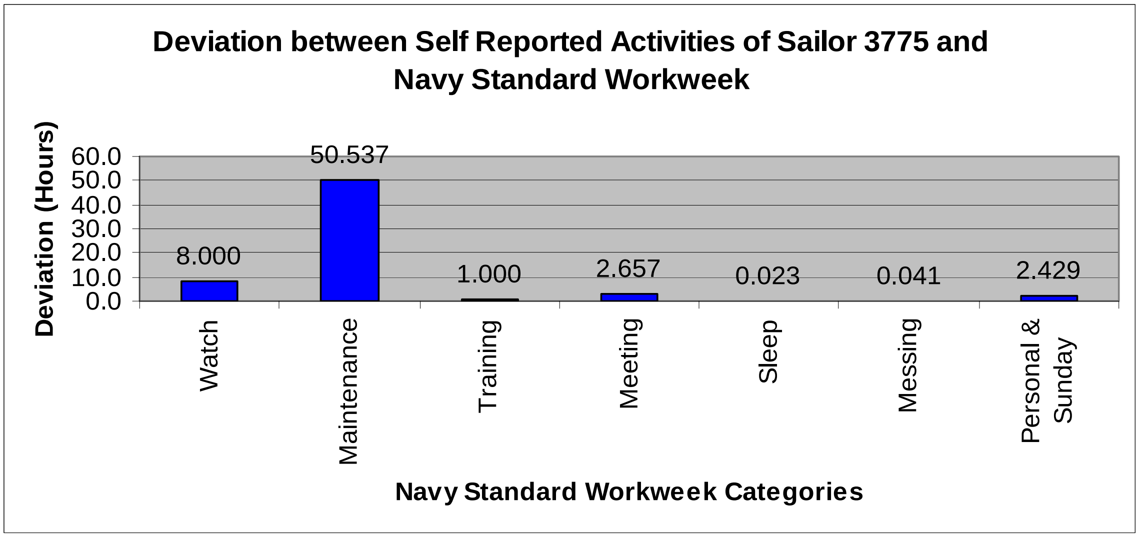
3771


Deviation between Self Reported Activities of Sailor 3772 and Navy Standard Workweek
Deviation (Hours)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1.125
0.352
0.797
0.020
0.407
0.230
0.089
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3772

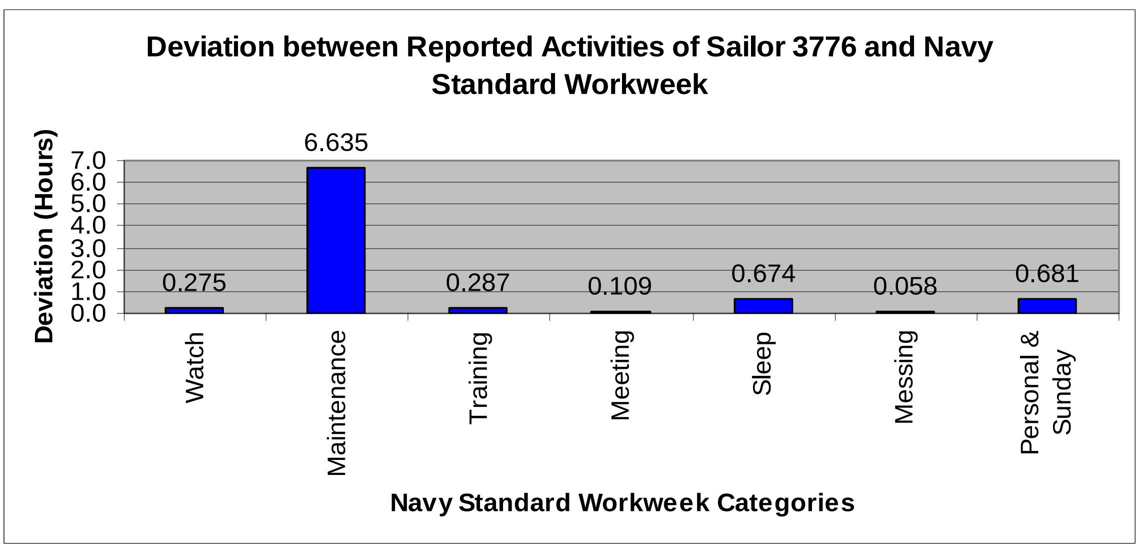

Deviation between Self Reported Activities of Sailor 3774 and Navy Standard Workweek
Deviation (Hours)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.148
0.184
0.617
0.469
0.016
0.184
0.134
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3774



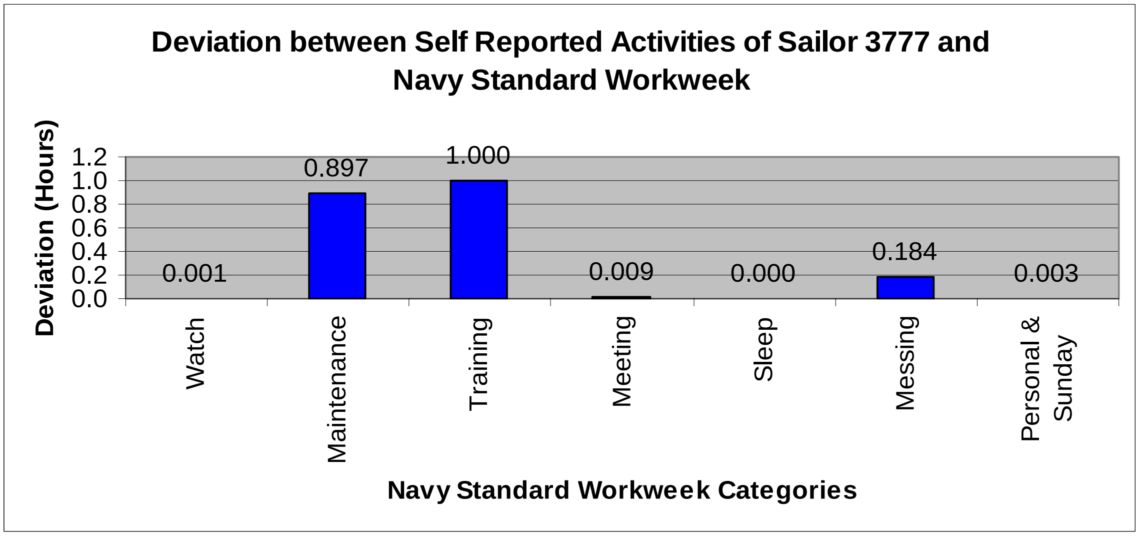
Deviation between Self Reported Activities of Sailor 3775 and Navy Standard Workweek
Deviation (Hours)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
8.000
50.537
1.000
2.657
0.023
0.041
2.429
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3775

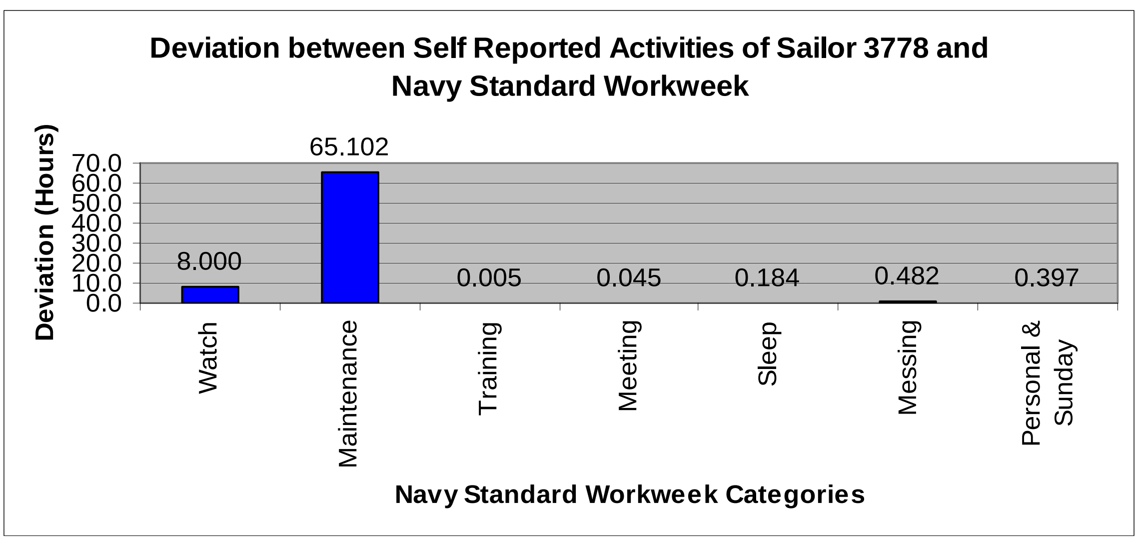


Deviation between Reported Activities of Sailor 3776 and Navy Standard Workweek
Deviation (Hours)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.275
6.635
0.287
0.109
0.674
0.058
0.681
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

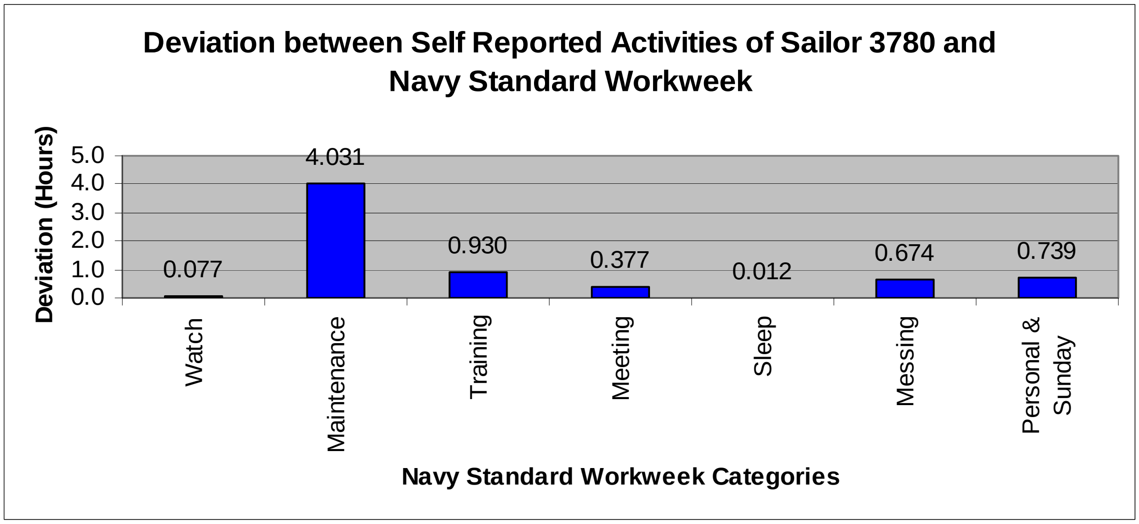
3776


Deviation between Self Reported Activities of Sailor 3777 and Navy Standard Workweek
Deviation (Hours)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.001
0.897
1.000
0.009
0.000
0.184
0.003
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

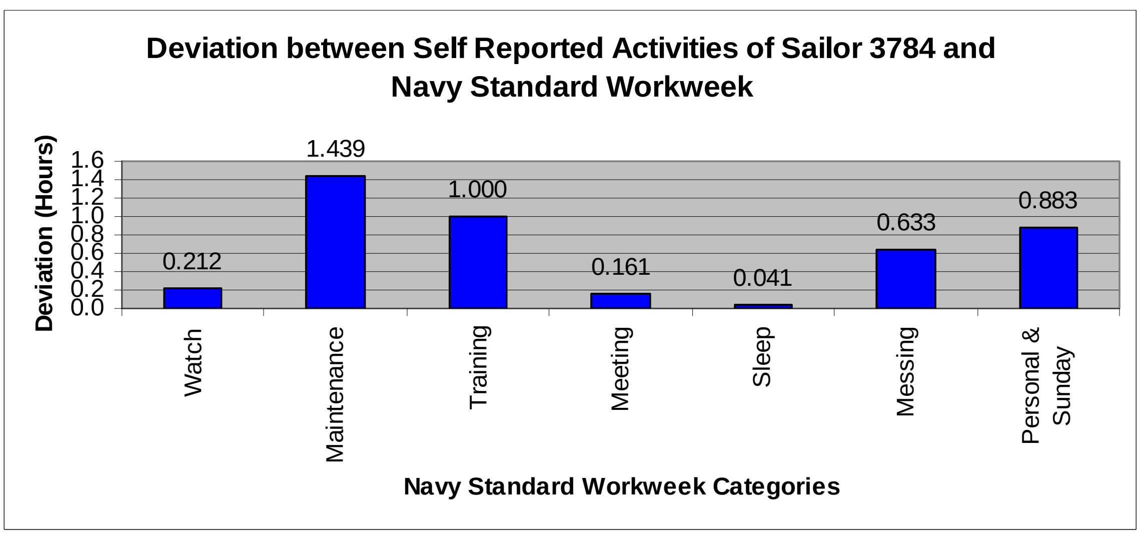
3777


Deviation between Self Reported Activities of Sailor 3778 and Navy Standard Workweek
Deviation (Hours)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
8.000
65.102
0.005
0.045
0.184
0.482
0.397
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

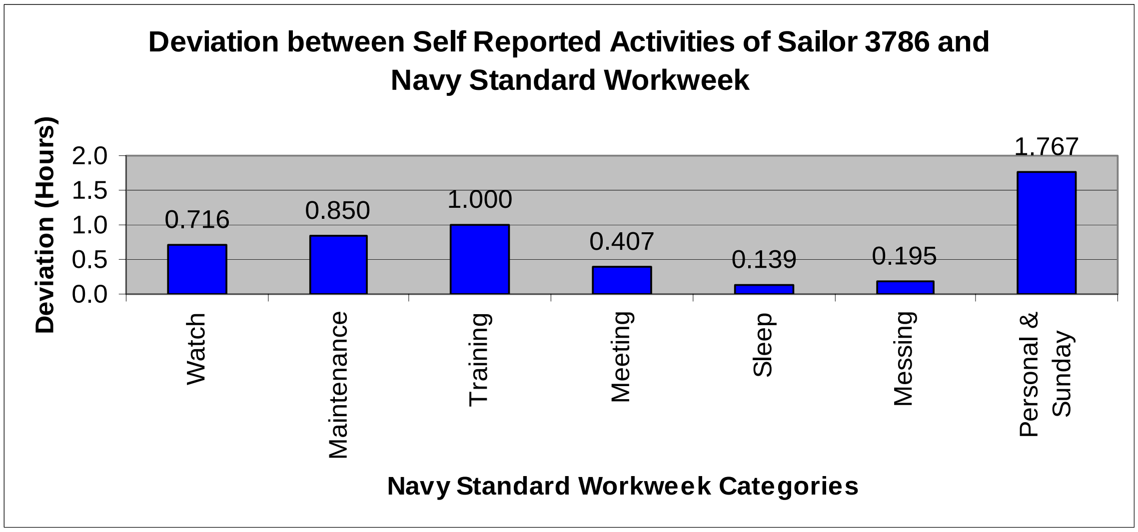
3778


Deviation between Self Reported Activities of Sailor 3780 and
Navy Standard Workweek
Deviation (Hours)
5.0
4.0
3.0
2.0
1.0
0.0
0.077
4.031
0.930
0.377
0.012
0.674
0.739
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3780

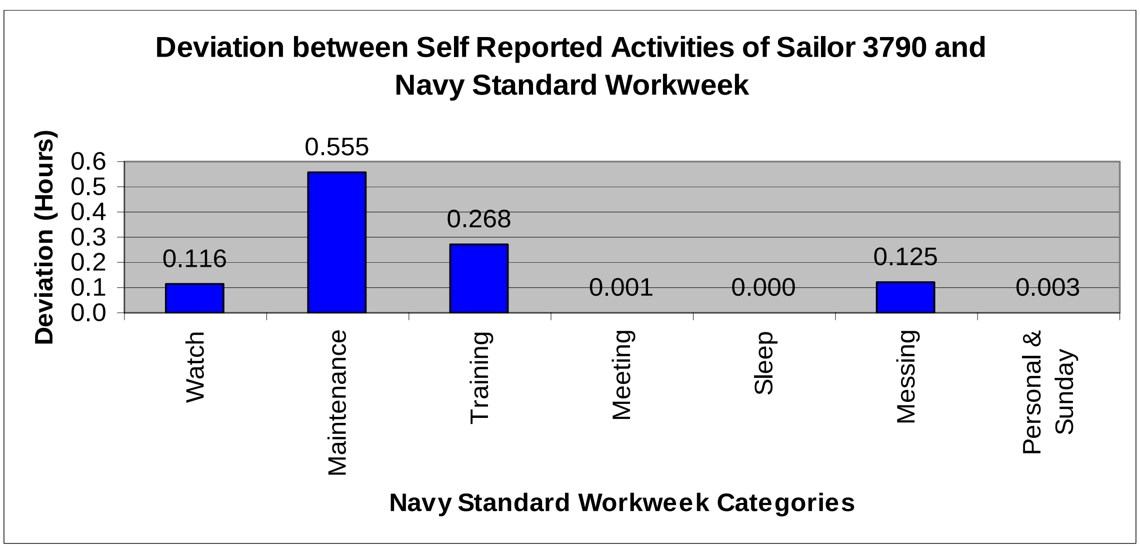

Deviation between Self Reported Activities of Sailor 3784 and
Navy Standard Workweek
Deviation (Hours)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.212
1.439
1.000
0.161
0.041
0.633
0.883
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3784



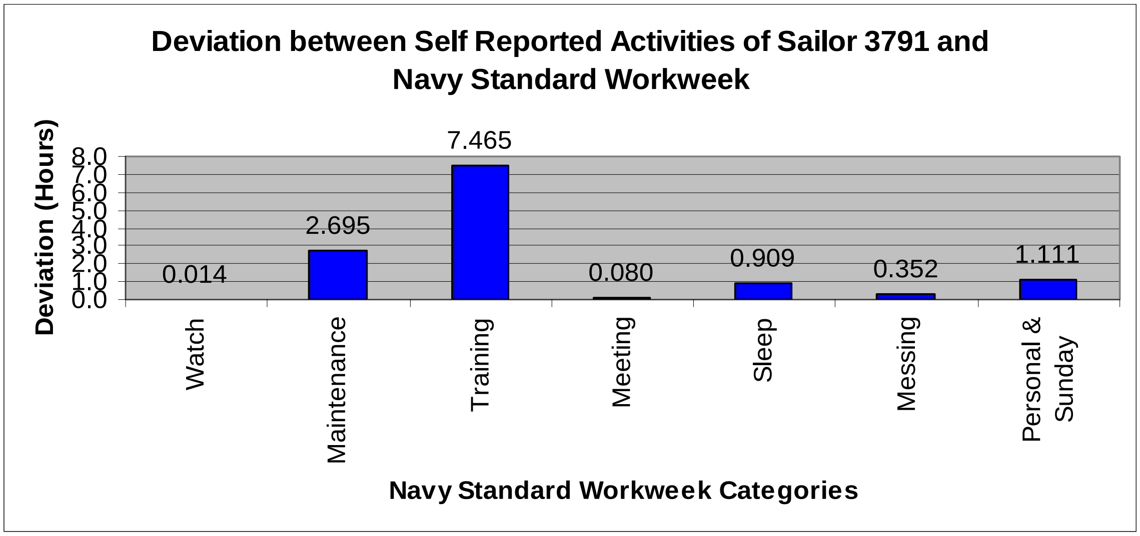
Deviation between Self Reported Activities of Sailor 3786 and Navy Standard Workweek
Deviation (Hours)
2.0
1.5
1.0
0.5
0.0
0.716
0.850
1.000
0.407
0.139
0.195
1.767
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3786

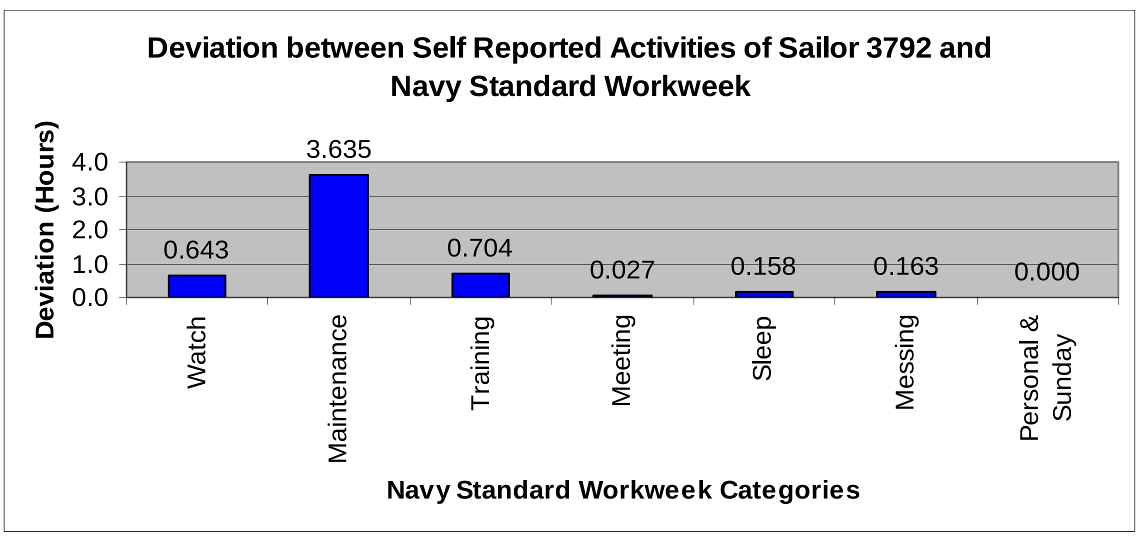


Deviation between Self Reported Activities of Sailor 3790 and Navy Standard Workweek
Deviation (Hours)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.116
0.555
0.268
0.001
0.000
0.125
0.003
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

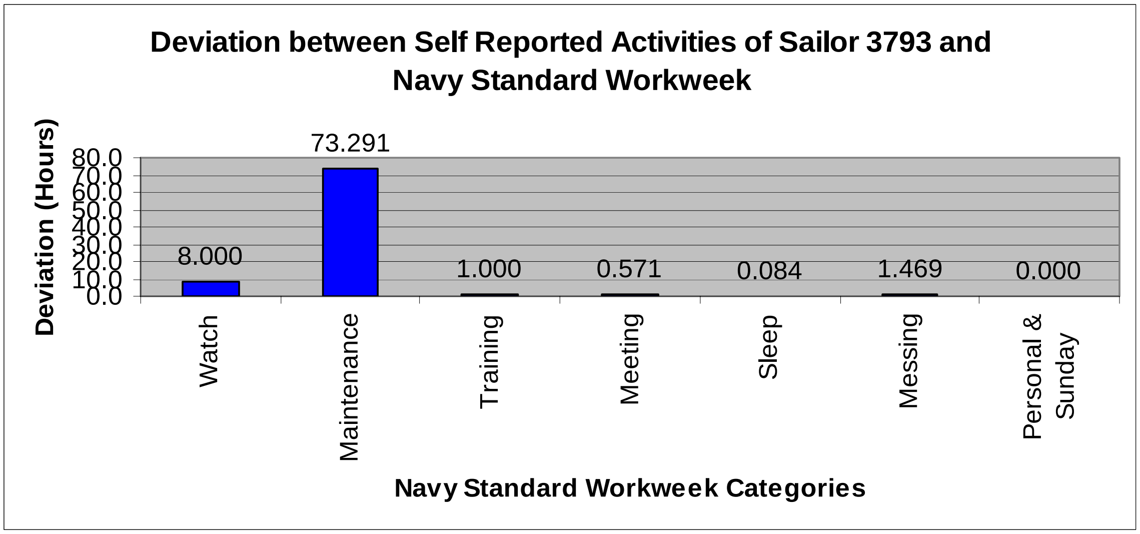
3790


Deviation between Self Reported Activities of Sailor 3791 and Navy Standard Workweek
Deviation (Hours)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.014
2.695
7.465
0.080
0.909
0.352
1.111
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3791


Deviation between Self Reported Activities of Sailor 3792 and Navy Standard Workweek
Deviation (Hours)
4.0
3.0
2.0
1.0
0.0
0.643
3.635
0.704
0.027
0.158
0.163
0.000
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3792


Deviation between Self Reported Activities of Sailor 3793 and
Navy Standard Workweek
Deviation (Hours)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
8.000
73.291
1.000
0.571
0.084
1.469
0.000
Watch
Maintenance
Training
Meeting
Sleep
Messing
Personal & Sunday
Navy Standard Workweek Categories

3793

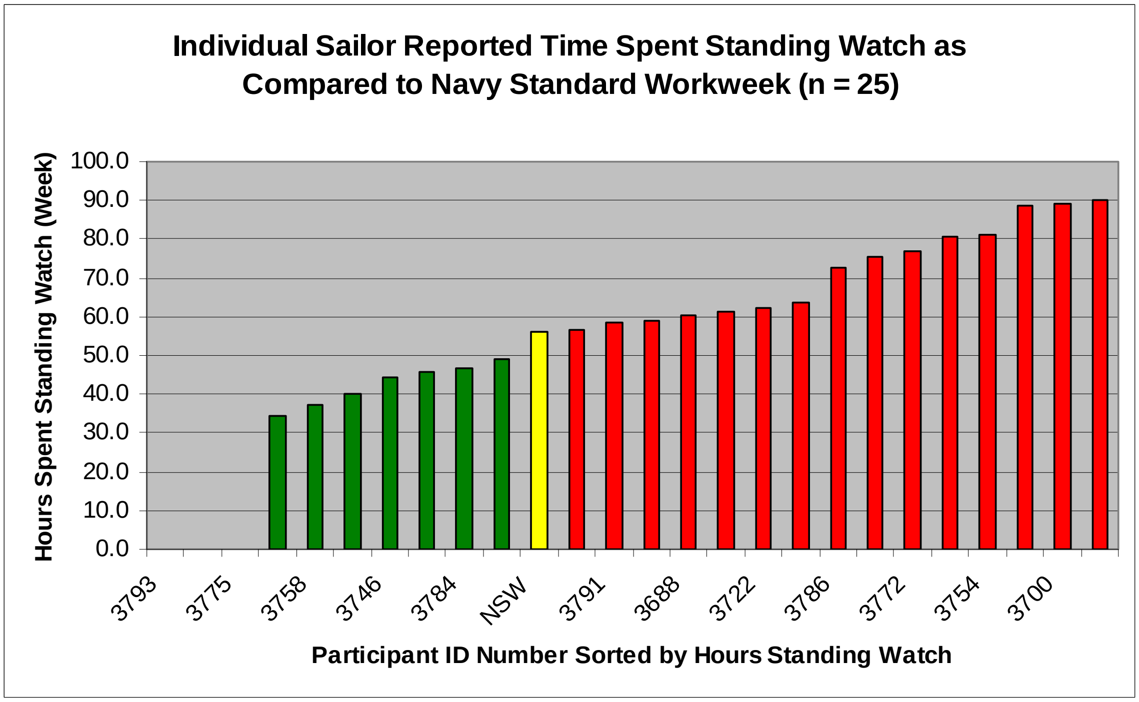
THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX E. SUMMARY TABLE OF REPORTED ACTIVITY OF INDIVIDUAL SAILORS

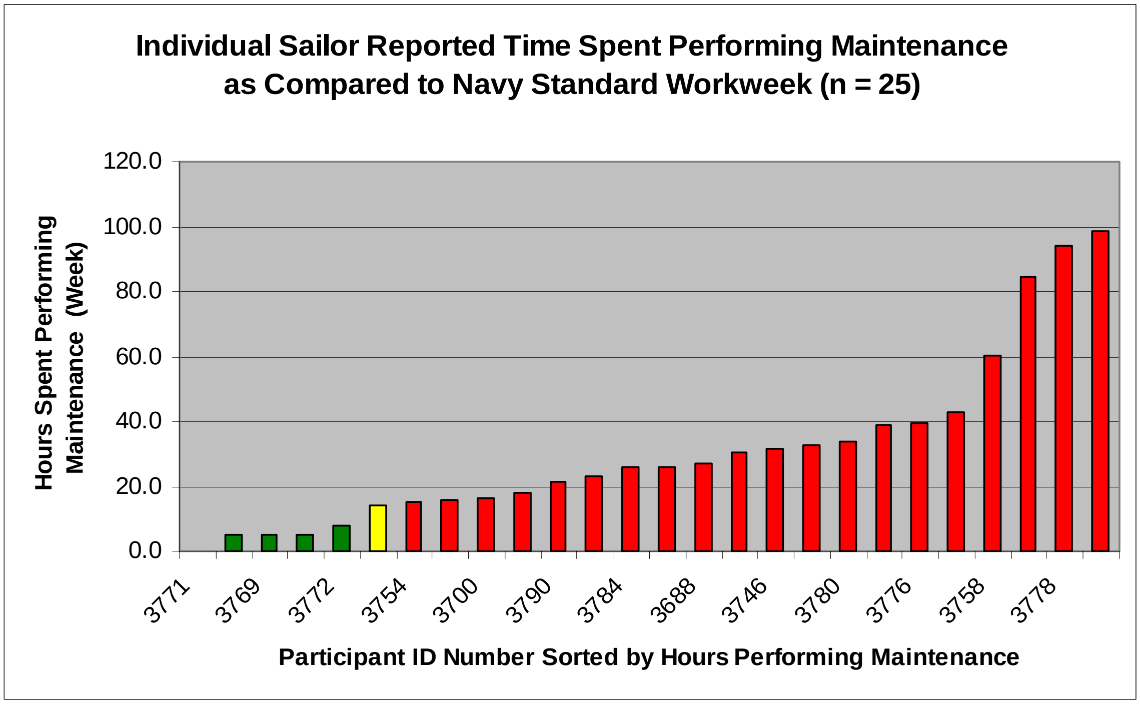
2 Week Average Time Spent Per Person (Hours)/Week							
Watch #	**Watch**	**Maintenance**	**Training**	**Meeting**	**Sleep**	**Messing**	**Personal & Sunday**
NSW	**56**	**14**	**7**	**4**	**56**	**14**	**17**
3772	77.00	8.13	13.25	3.25	43.38	9.25	13.75
3764	75.38	26.13	0.00	5.63	45.50	7.38	8.00
3774	63.63	18.25	1.50	0.38	53.50	9.75	21.00
3780	61.50	33.88	0.25	0.75	58.13	5.88	7.63
3700	89.25	16.13	0.00	0.50	38.50	2.75	20.88
3753	58.75	42.88	0.00	1.88	56.88	7.38	0.25
3784	46.88	25.88	0.00	1.88	60.00	6.13	27.25
3761	89.88	5.13	1.13	4.00	49.75	3.75	14.38
3771	88.63	0.00	1.00	0.00	61.50	7.00	9.88
3722	62.38	15.88	3.13	1.88	53.00	10.00	21.75
3746	44.38	31.75	2.00	15.13	46.75	19.13	8.88
3792	40.13	32.88	1.13	3.13	63.88	10.00	16.88
3758	37.38	60.25	2.25	0.00	51.63	7.75	8.75
3786	72.75	4.88	0.00	0.63	48.63	9.63	31.50
3793	0.00	98.75	0.00	0.00	50.25	2.00	17.00
3778	0.00	93.88	6.50	2.88	47.50	7.13	10.13
3777	56.75	23.38	0.00	4.50	56.00	9.75	17.63
3791	58.38	30.25	26.13	2.50	37.13	8.13	5.50
3775	0.00	84.38	0.00	12.63	59.00	12.00	0.00
3688	60.50	27.00	7.00	4.50	44.63	9.88	14.50
3737	34.25	39.13	0.00	3.50	63.50	13.88	13.75
3769	80.75	5.00	17.63	0.88	48.13	7.00	8.63
3790	49.25	21.38	10.63	3.88	56.00	10.50	16.38
3776	45.63	39.50	3.25	2.25	39.75	11.63	26.00
3754	81.00	15.00	3.63	5.63	44.25	5.25	7.25
Average =	54.98	31.99	4.02	3.29	51.09	8.52	13.90
Std Dev =	25.80	26.16	6.38	3.57	7.53	3.52	7.78

THIS PAGE INTENTIONALLY LEFT BLANK

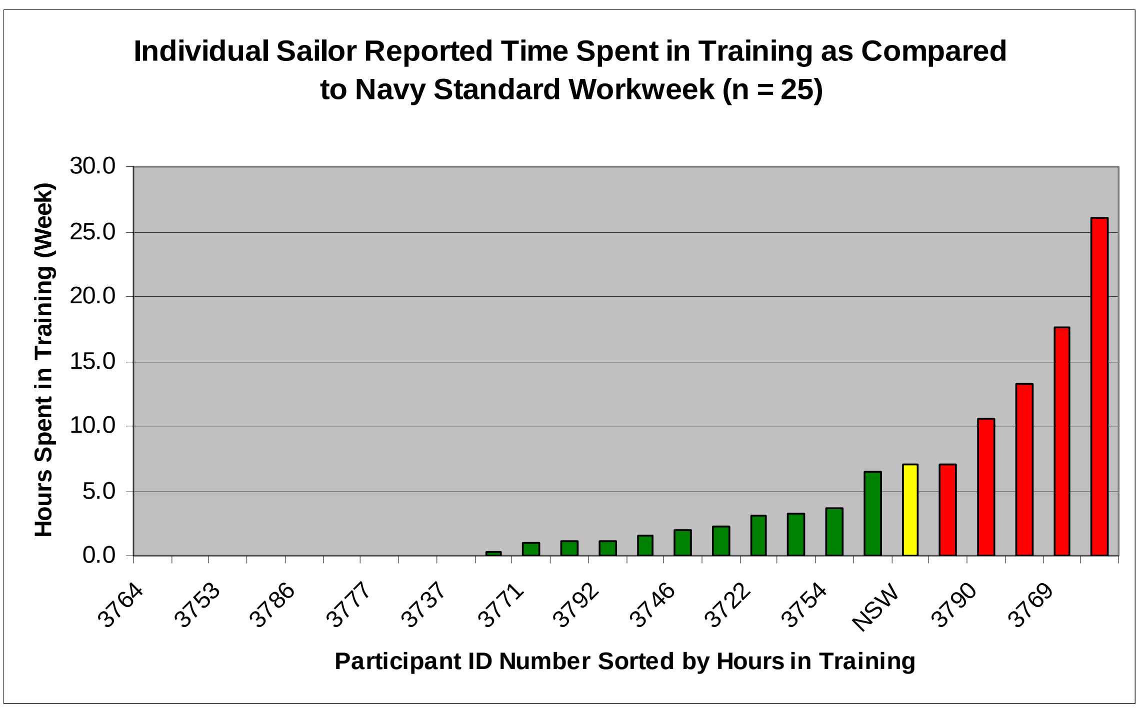
APPENDIX F INDIVIDUAL SAILOR VARIATION BY NAVY STANDARD WORKWEEK CATEGORIES



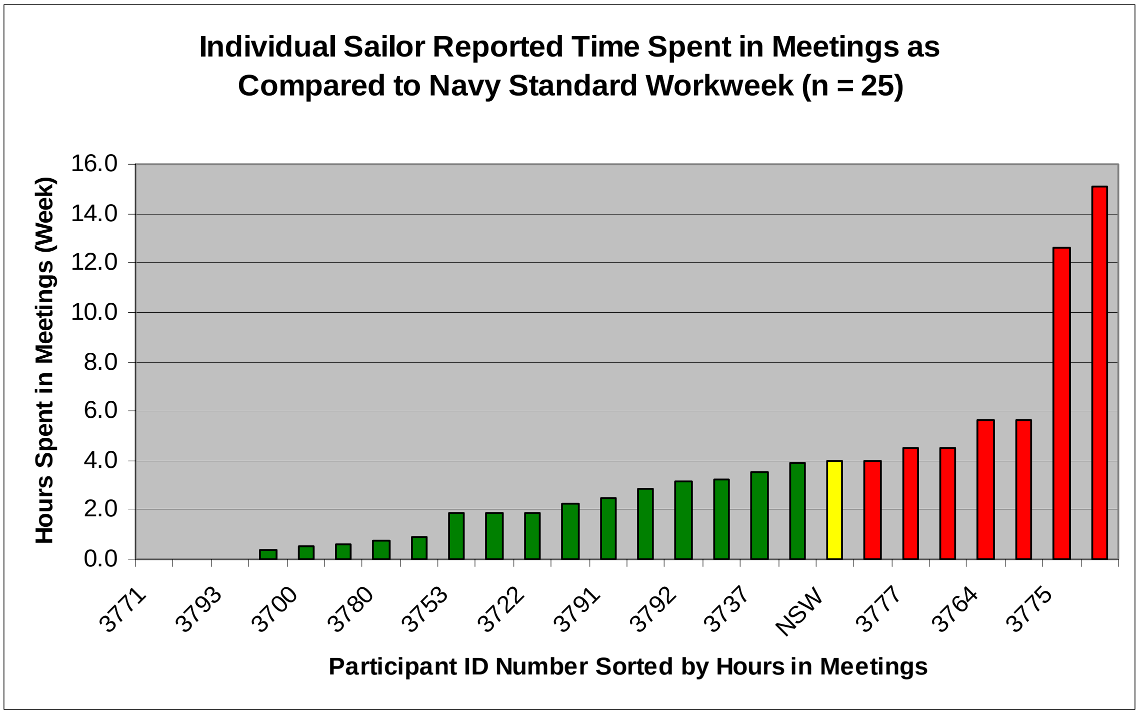
Individual Sailor Time Spent Standing Watch



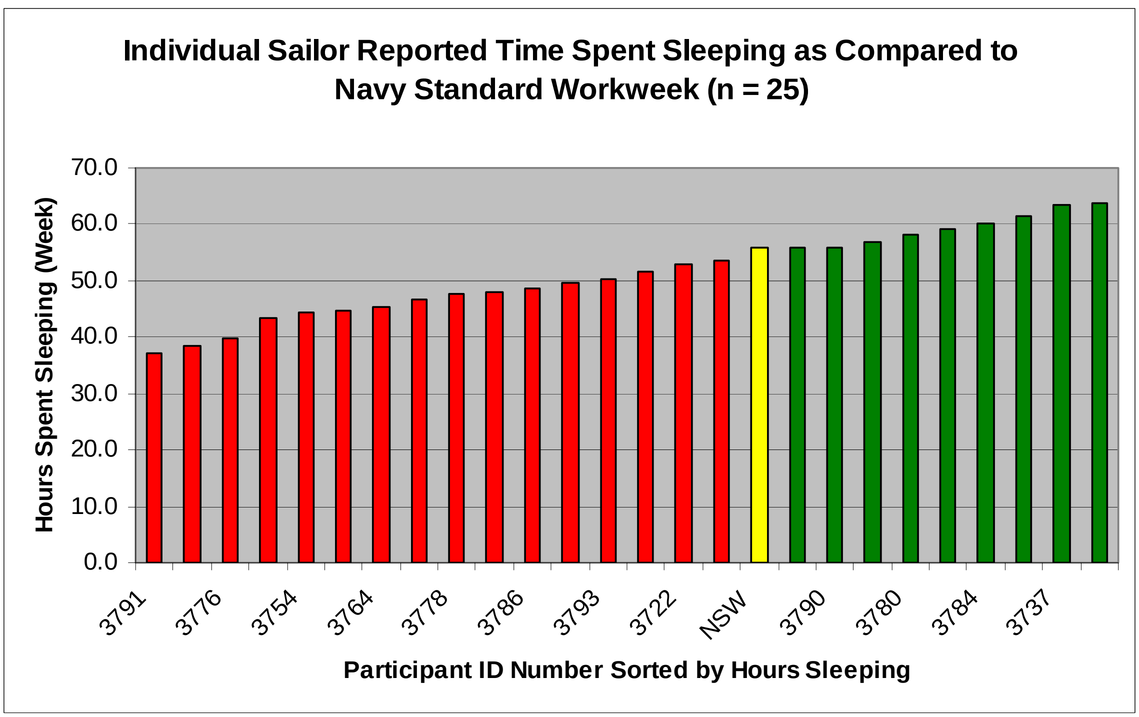
Individual Sailor Time Spent Performing Maintenance



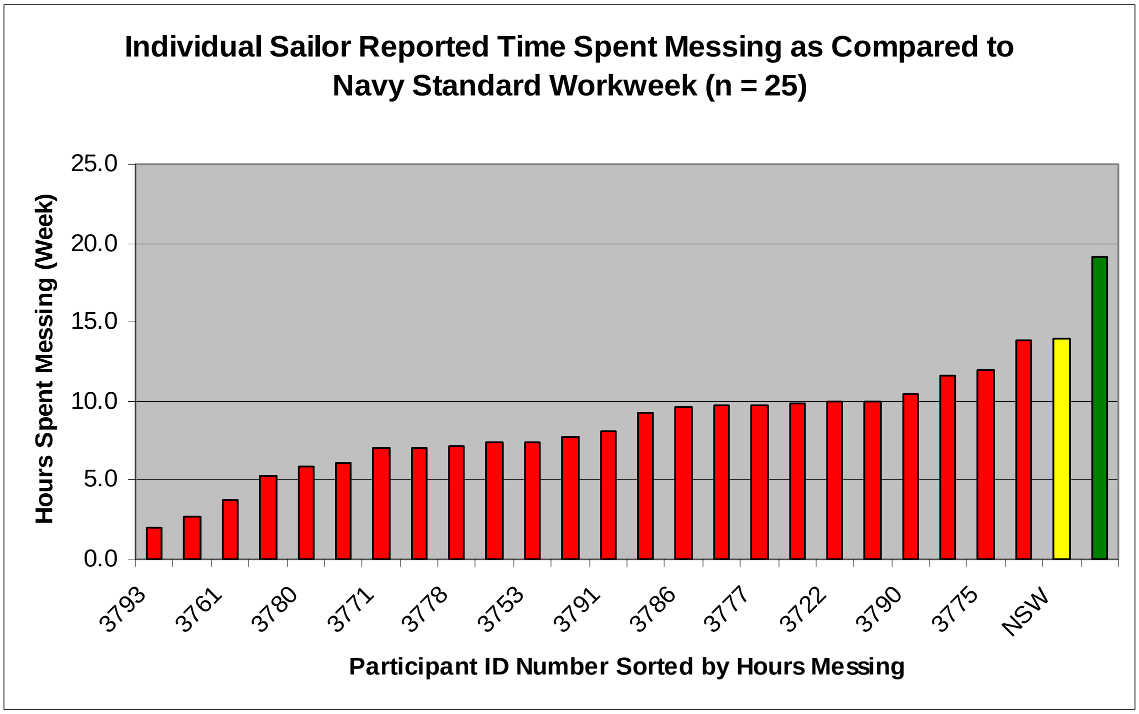
Individual Sailor Time Spent in Training



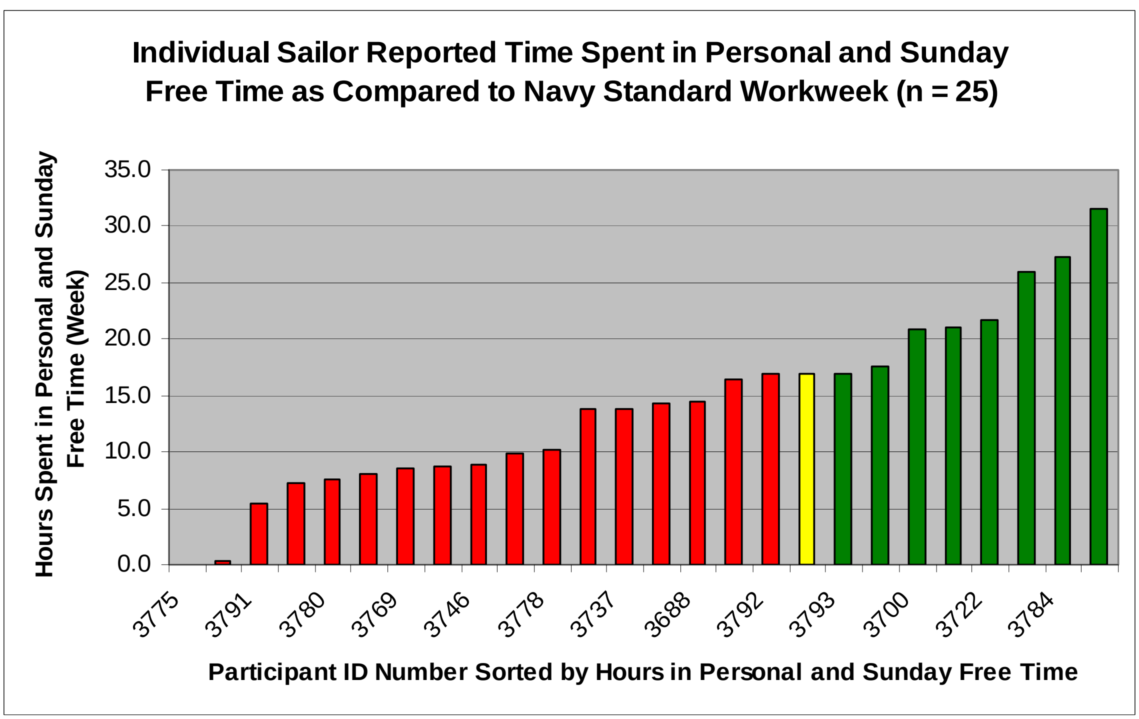
Individual Sailor Time Spent in Meetings



Individual Sailor Time Spent Sleeping



Individual Sailor Time Spent Messing



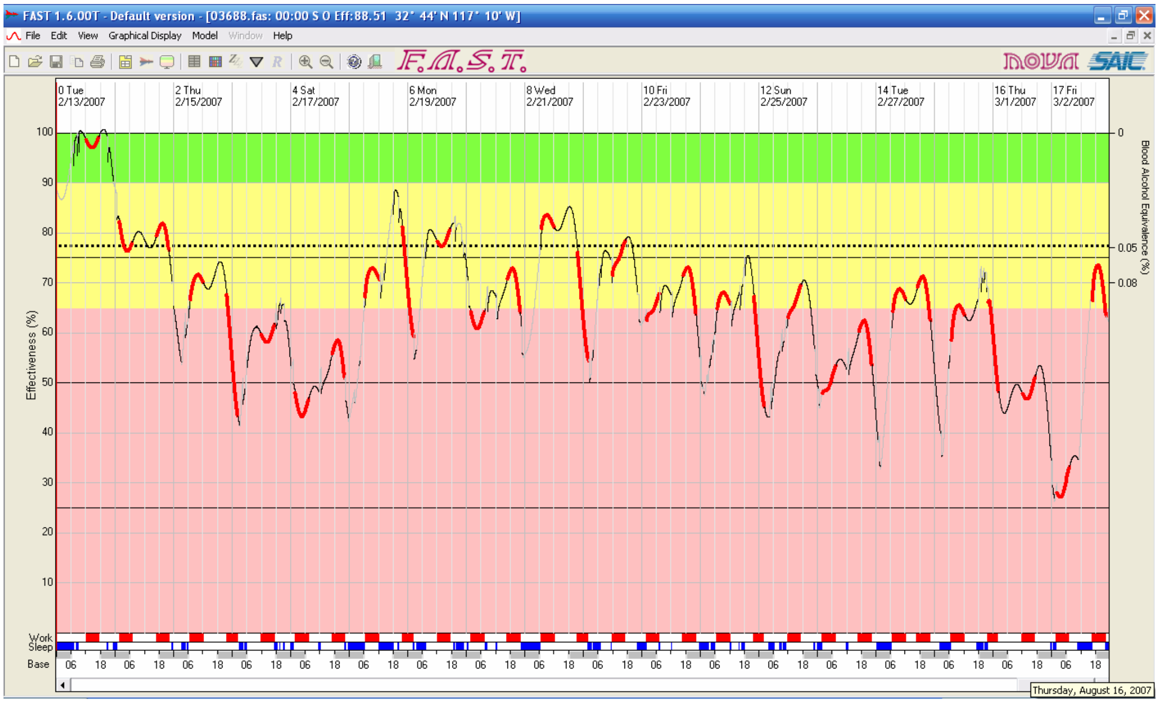
Individual Sailor Time Spent in Personal and Sunday Free Time

APPENDIX G. SUMMARY TABLE OF INDIVIDUAL SAILOR REPORTED AVAILABLE AND NON-AVAILABLE TIME

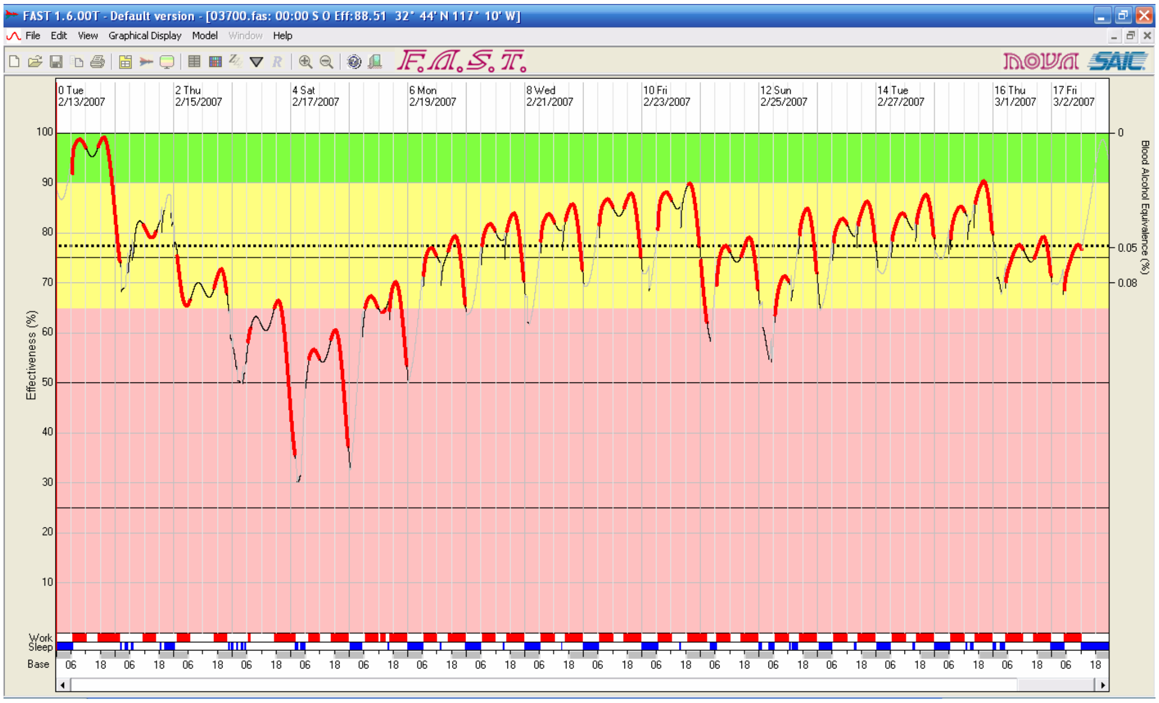
Reported		
Watch #	**Available**	**Non-Available**
NSW	**81**	**87**
3772	103.25	64.75
3764	106.97	61.03
3774	84.10	83.90
3780	99.96	68.04
3700	105.00	63.00
3753	100.52	67.48
3784	71.85	96.15
3761	103.44	64.56
3771	88.28	79.72
3722	82.14	85.86
3746	94.19	73.81
3792	80.17	87.83
3758	98.72	69.28
3786	74.47	93.53
3793	99.97	68.03
3778	103.25	64.75
3777	88.27	79.73
3791	117.97	50.03
3775	97.22	70.78
3688	102.53	65.47
3737	75.80	92.20
3769	105.00	63.00
3790	84.10	83.90
3776	89.15	78.85
3754	103.65	64.35
Average =	94.40	73.60
Std Dev =	11.86	11.86

THIS PAGE INTENTIONALLY LEFT BLANK

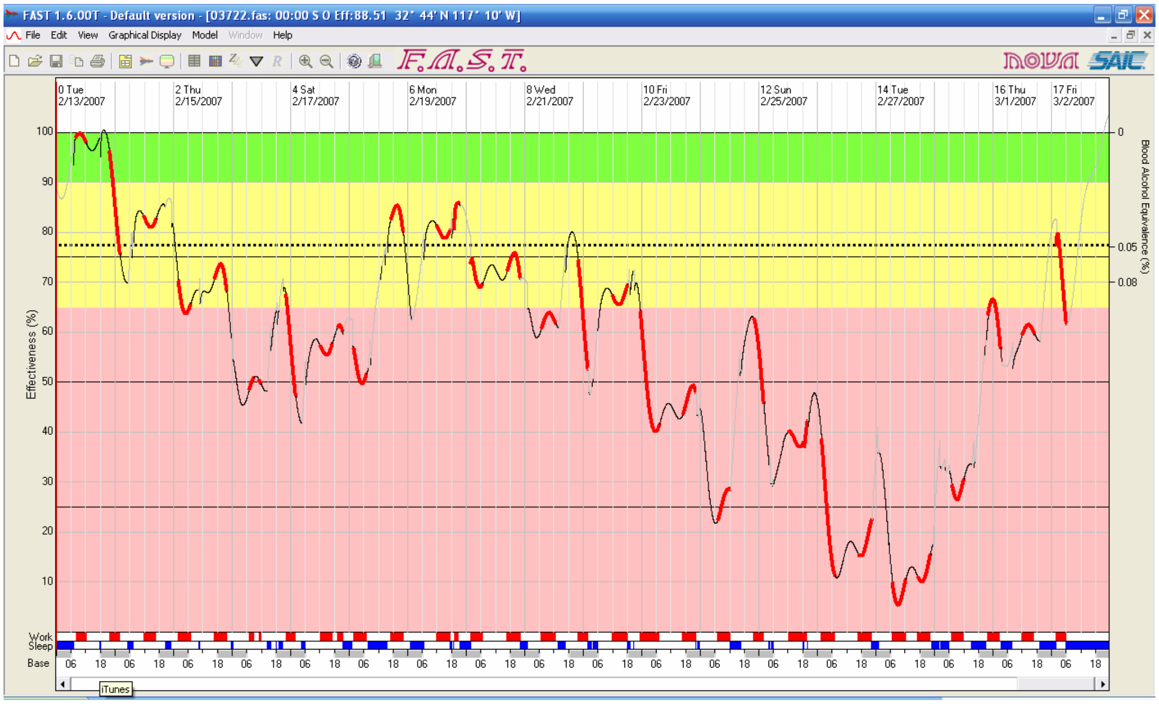
APPENDIX H. INDIVIDUAL SAILOR FAST PLOTS



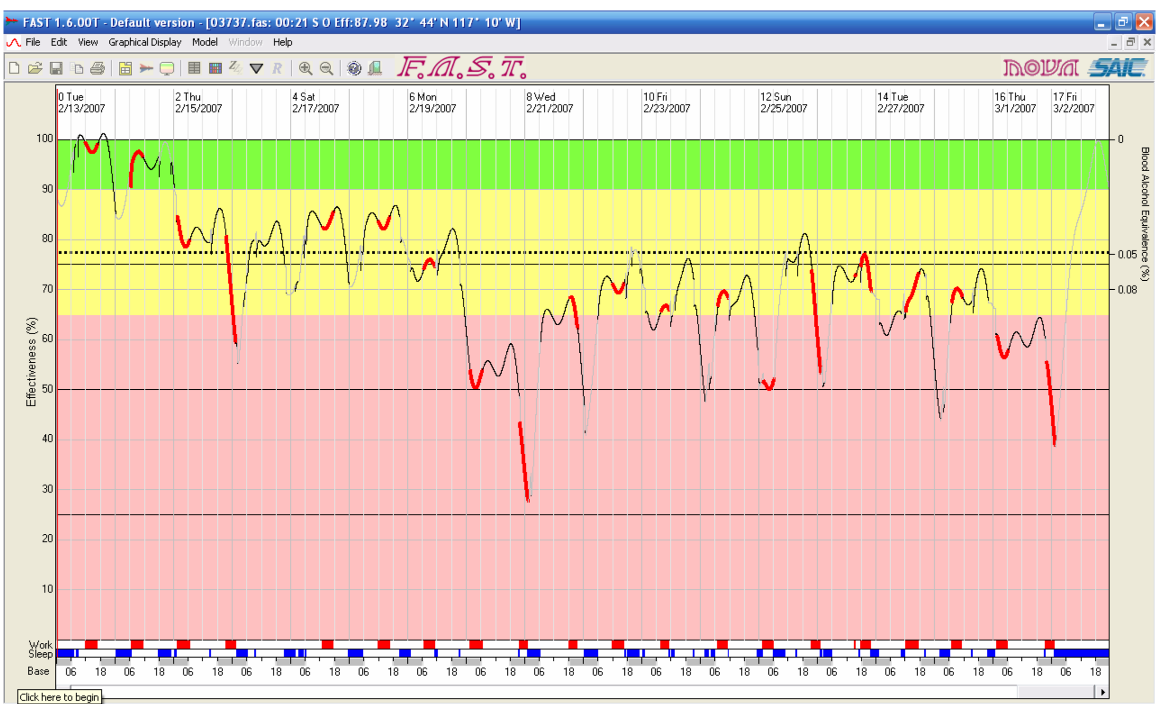
3688



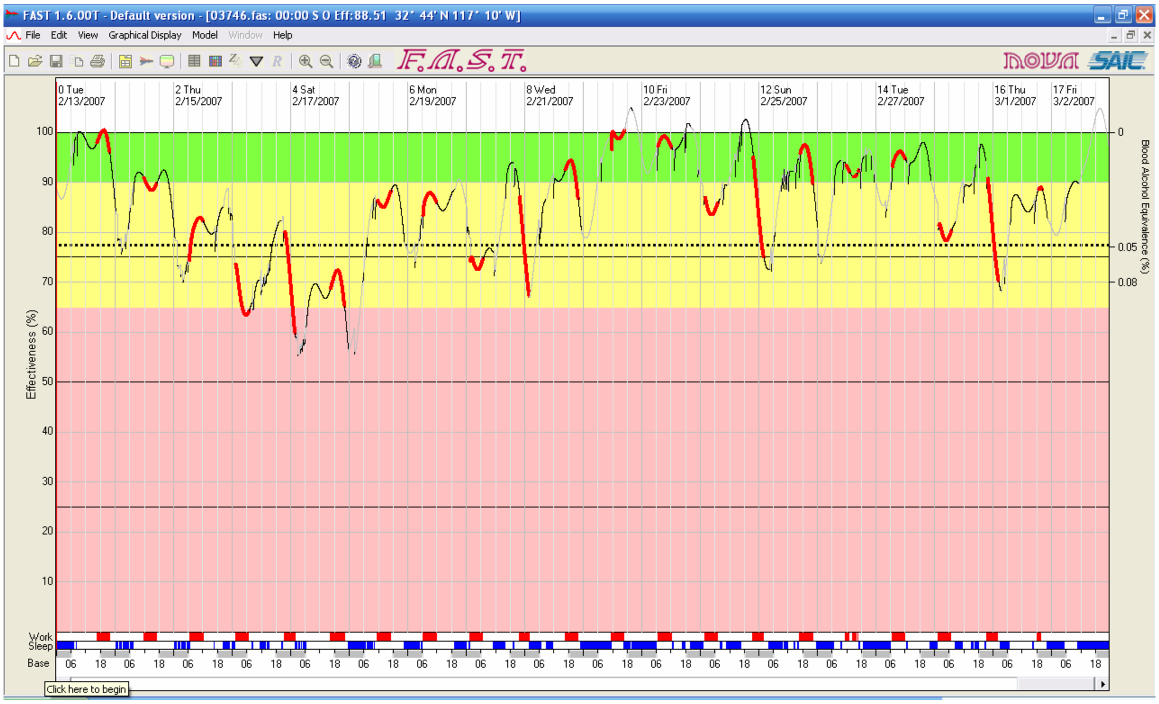
3700


FAST 1.6.00T - Default version - [03722.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
NOVA SAIC
0 Tue 2/13/2007
2 Thu 2/15/2007
4 Sat 2/17/2007
6 Mon 2/19/2007
8 Wed 2/21/2007
10 Fri 2/23/2007
12 Sun 2/25/2007
14 Tue 2/27/2007
16 Thu 3/1/2007
17 Fri 3/2/2007
Effectiveness (%)
Blood Alcohol Equivalence (%)
0.05
0.08
Work
Sleep
Base
iTunes

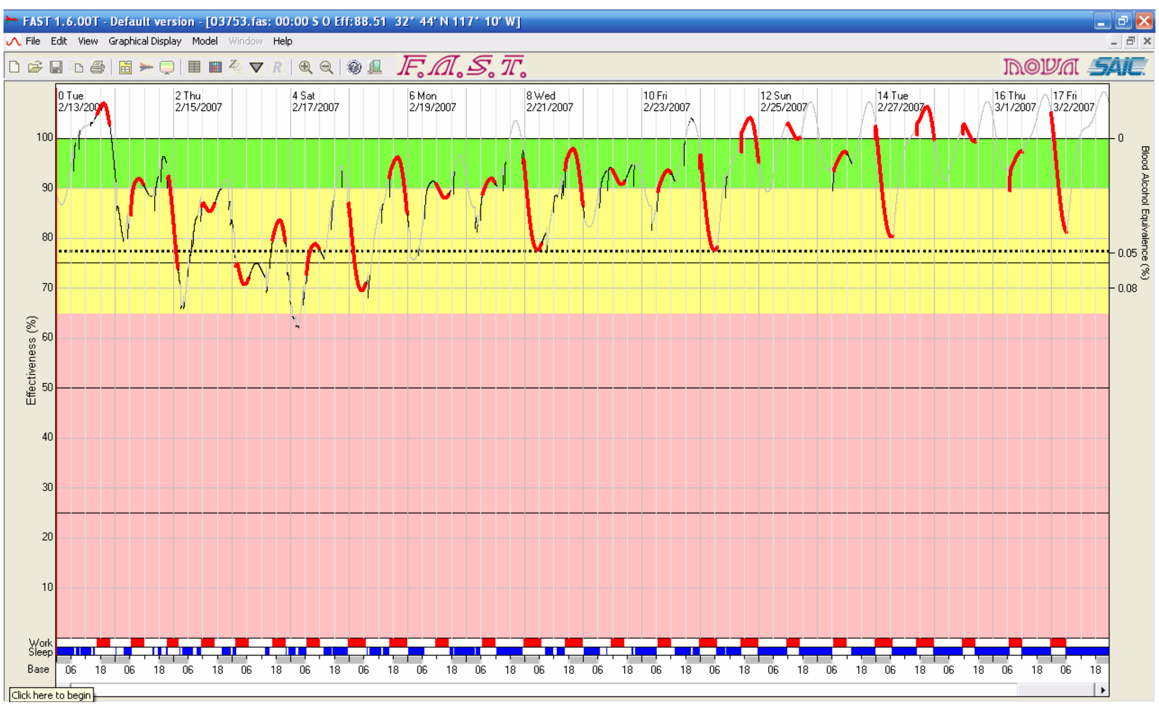
3722


FAST 1.6.00T - Default version - [03737.fas: 00:21 S O Eff:87.98 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
NOVA SAIC
0 Tue 2/13/2007
2 Thu 2/15/2007
4 Sat 2/17/2007
6 Mon 2/19/2007
8 Wed 2/21/2007
10 Fri 2/23/2007
12 Sun 2/25/2007
14 Tue 2/27/2007
16 Thu 3/1/2007
17 Fri 3/2/2007
Effectiveness (%)
Blood Alcohol Equivalence (%)
0.05
0.08
Work
Sleep
Base
Click here to begin

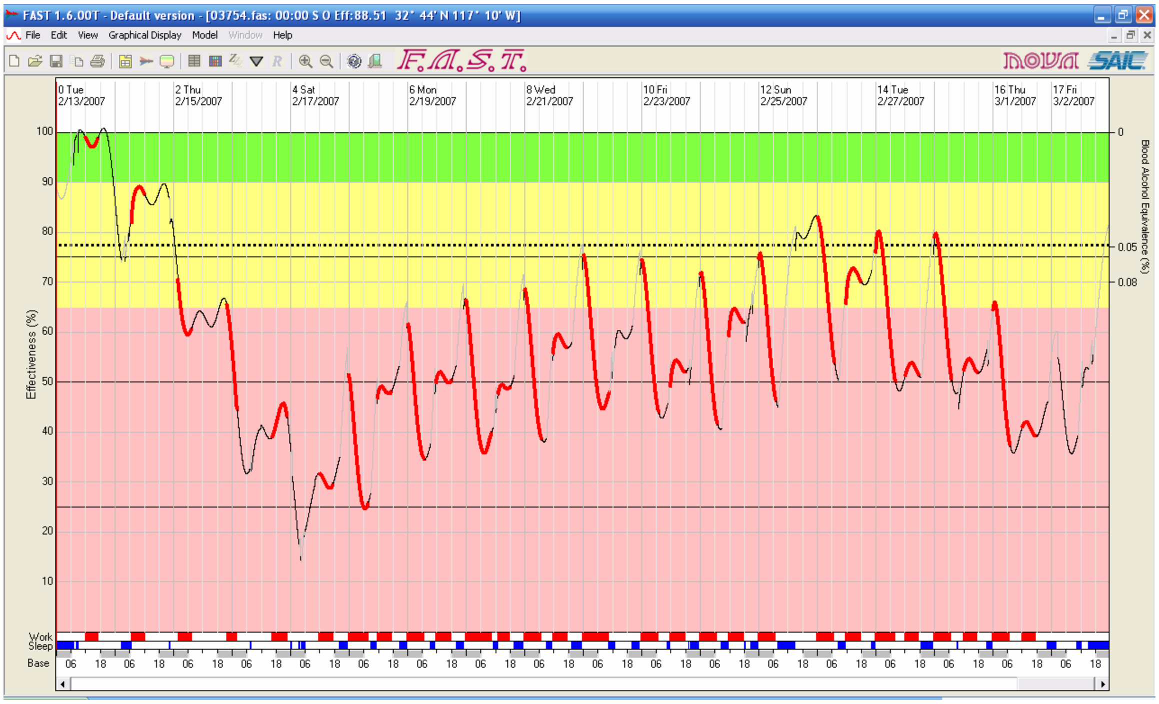
3737


FAST 1.6.00T - Default version - [03746.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base
Click here to begin

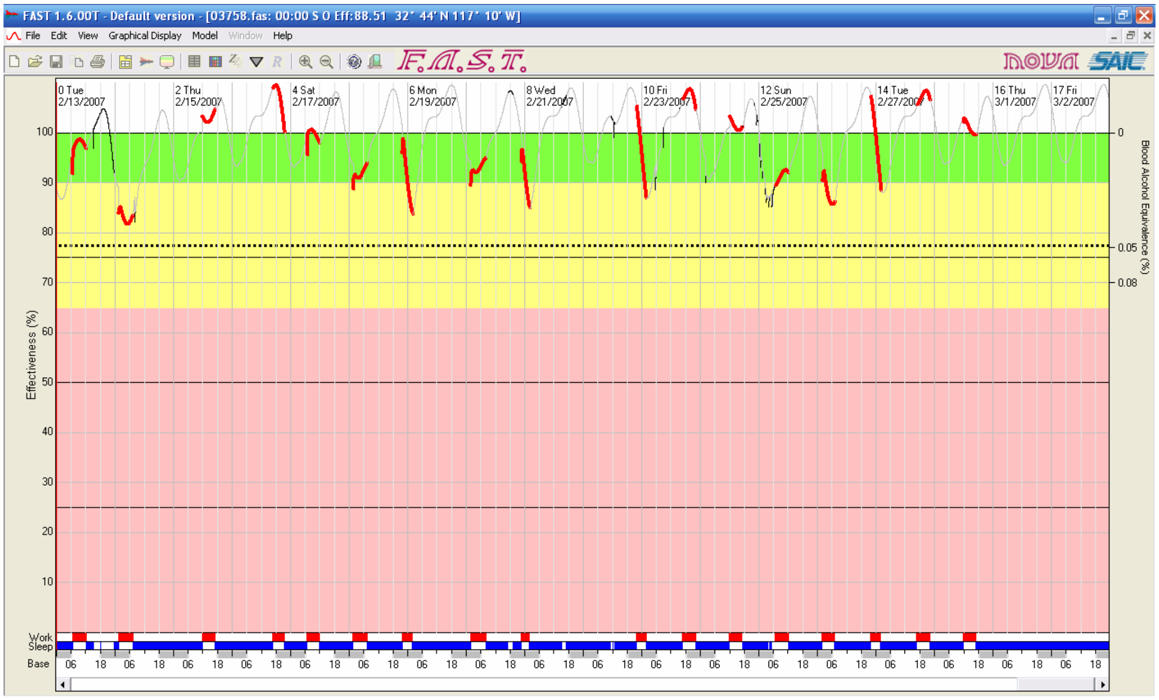
3746


FAST 1.6.00T - Default version - [03753.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base
Click here to begin

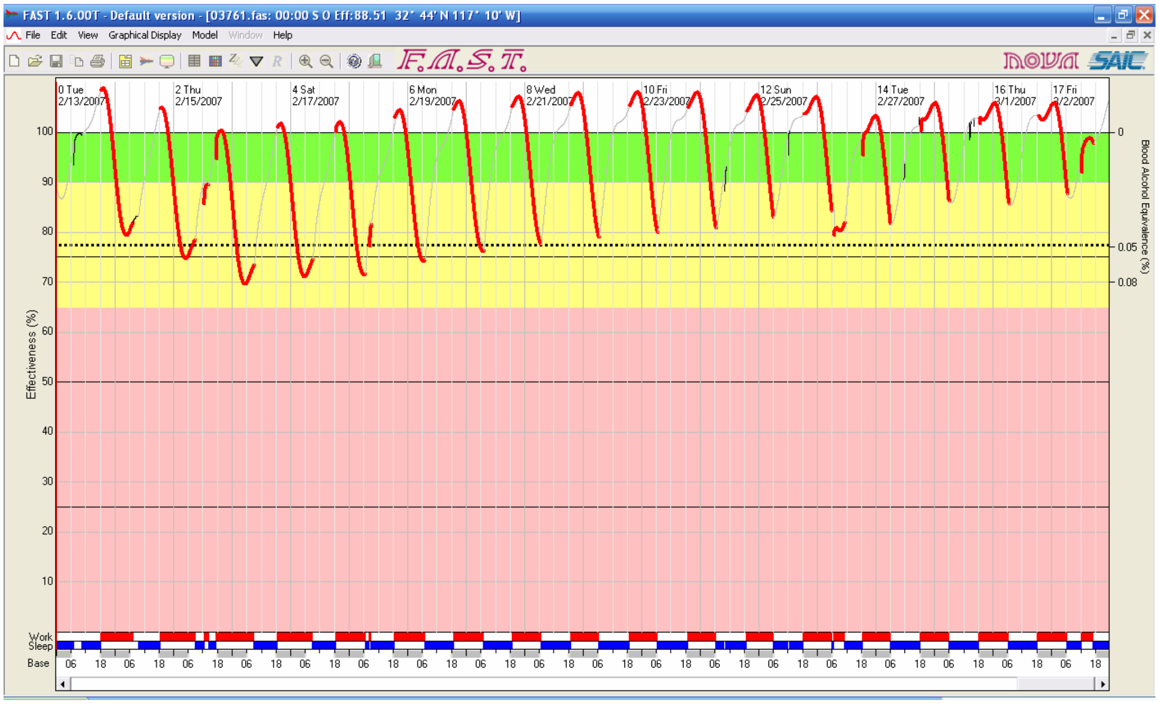
3753



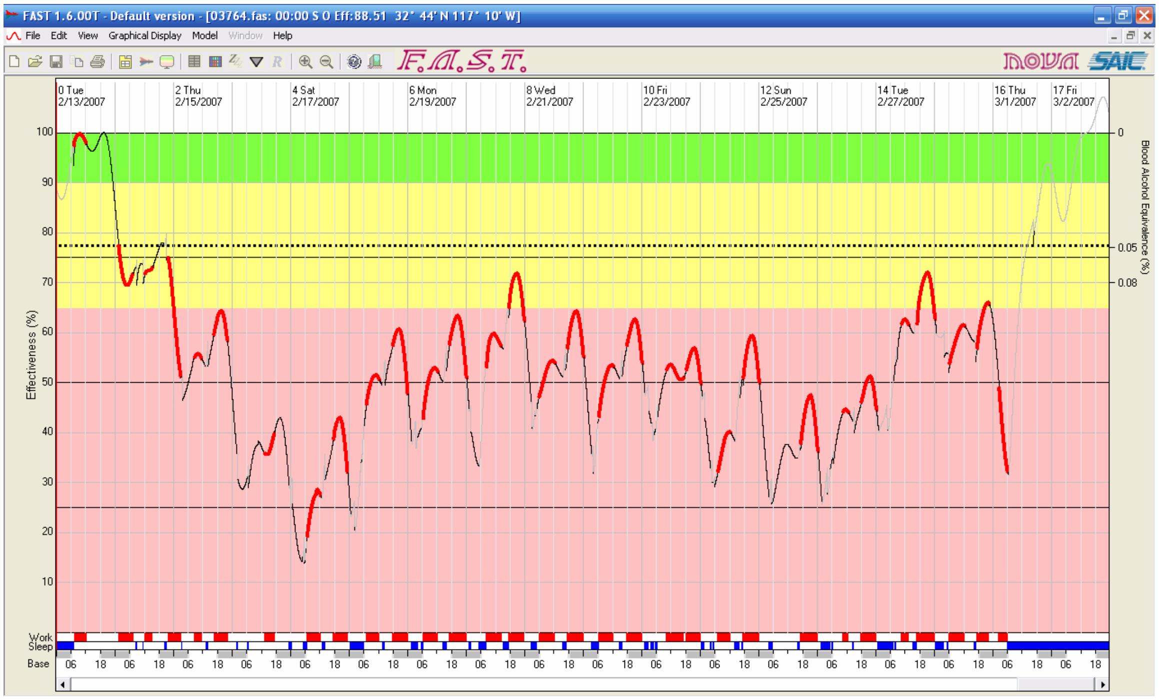
3754



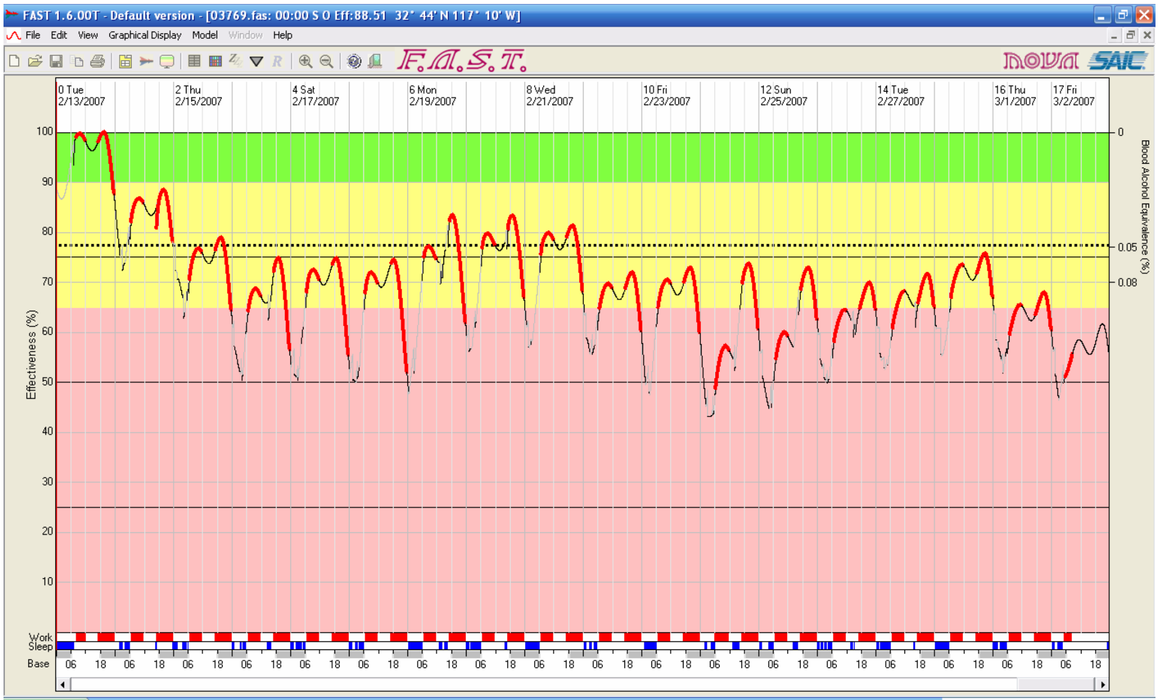
3758


FAST 1.6.00T - Default version - [03761.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
0 Tue 2/13/2007
2 Thu 2/15/2007
4 Sat 2/17/2007
6 Mon 2/19/2007
8 Wed 2/21/2007
10 Fri 2/23/2007
12 Sun 2/25/2007
14 Tue 2/27/2007
16 Thu 3/1/2007
17 Fri 3/2/2007
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base

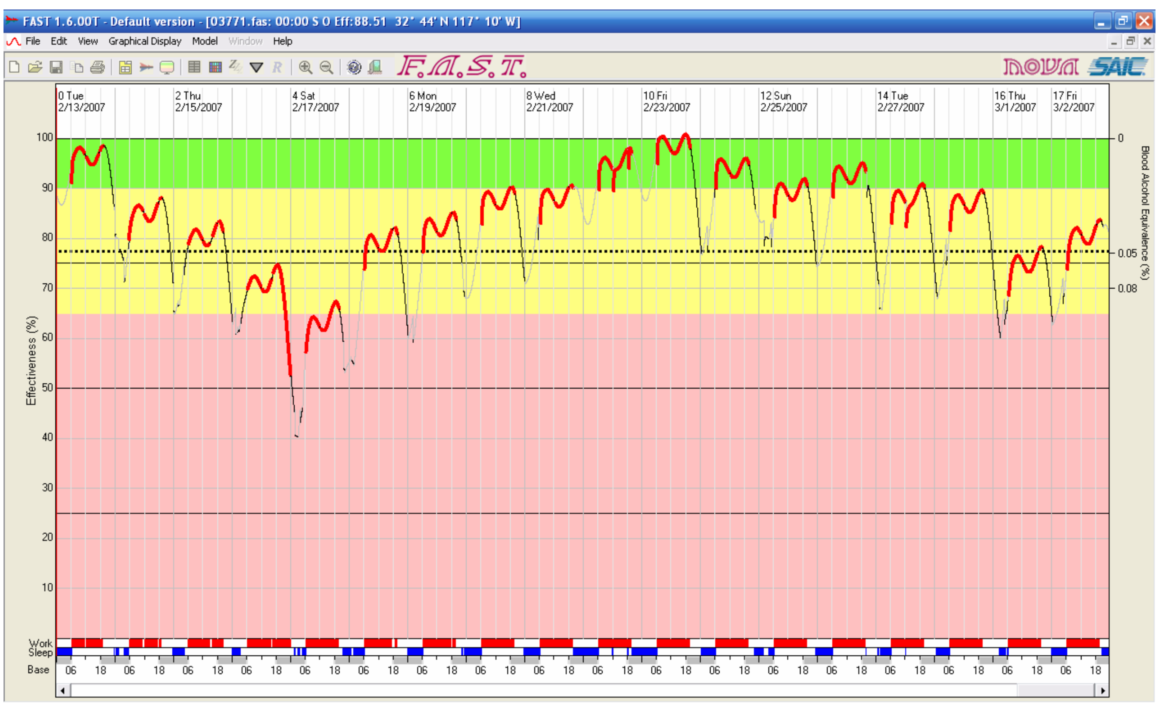
3761


FAST 1.6.00T - Default version - [03764.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
0 Tue 2/13/2007
2 Thu 2/15/2007
4 Sat 2/17/2007
6 Mon 2/19/2007
8 Wed 2/21/2007
10 Fri 2/23/2007
12 Sun 2/25/2007
14 Tue 2/27/2007
16 Thu 3/1/2007
17 Fri 3/2/2007
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base

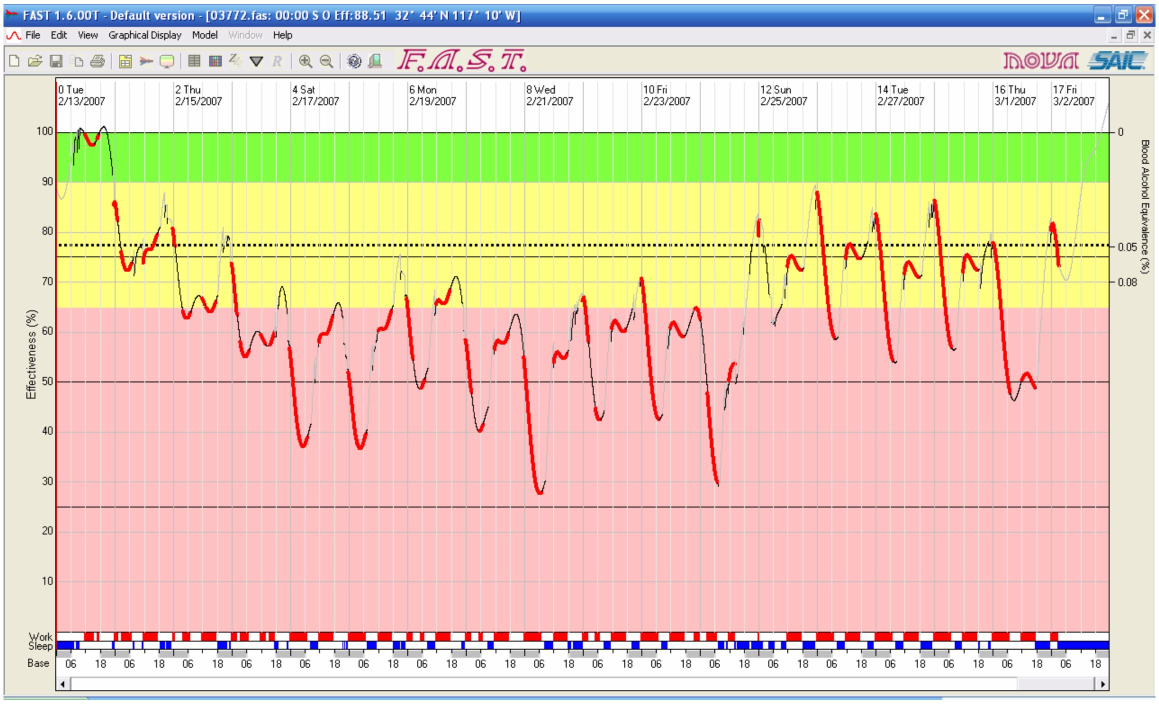
3764


FAST 1.6.00T - Default version - [03769.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
0 Tue 2/13/2007
2 Thu 2/15/2007
4 Sat 2/17/2007
6 Mon 2/19/2007
8 Wed 2/21/2007
10 Fri 2/23/2007
12 Sun 2/25/2007
14 Tue 2/27/2007
16 Thu 3/1/2007
17 Fri 3/2/2007
Effectiveness (%)
Blood Alcohol Equivalence (%)
0
0.05
0.08
Work
Sleep
Base

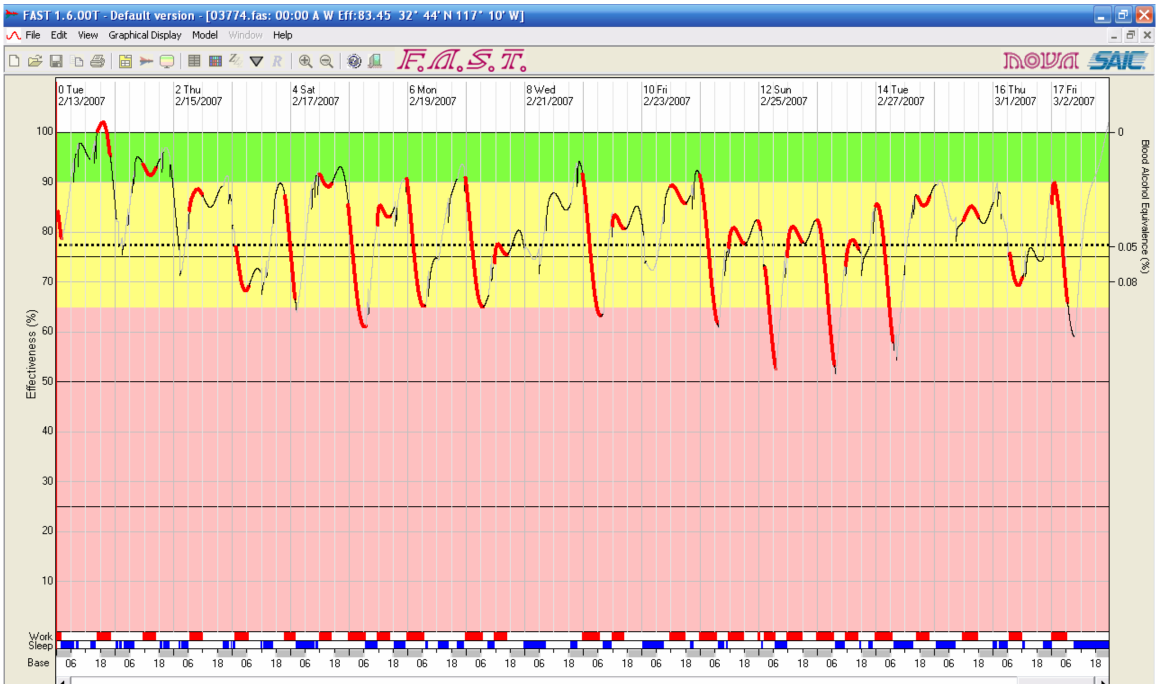
3769


FAST 1.6.00T - Default version - [03771.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
0 Tue 2/13/2007
2 Thu 2/15/2007
4 Sat 2/17/2007
6 Mon 2/19/2007
8 Wed 2/21/2007
10 Fri 2/23/2007
12 Sun 2/25/2007
14 Tue 2/27/2007
16 Thu 3/1/2007
17 Fri 3/2/2007
Effectiveness (%)
Blood Alcohol Equivalence (%)
0
0.05
0.08
Work
Sleep
Base

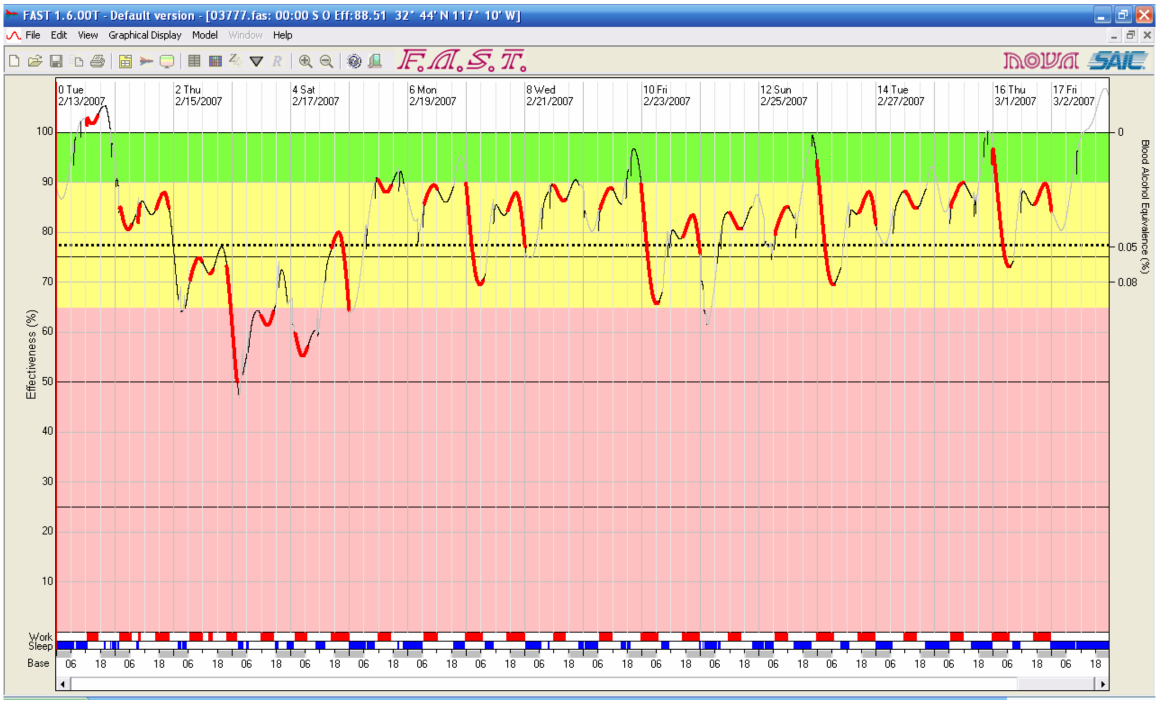
3771


FAST 1.6.00T - Default version - [03772.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base

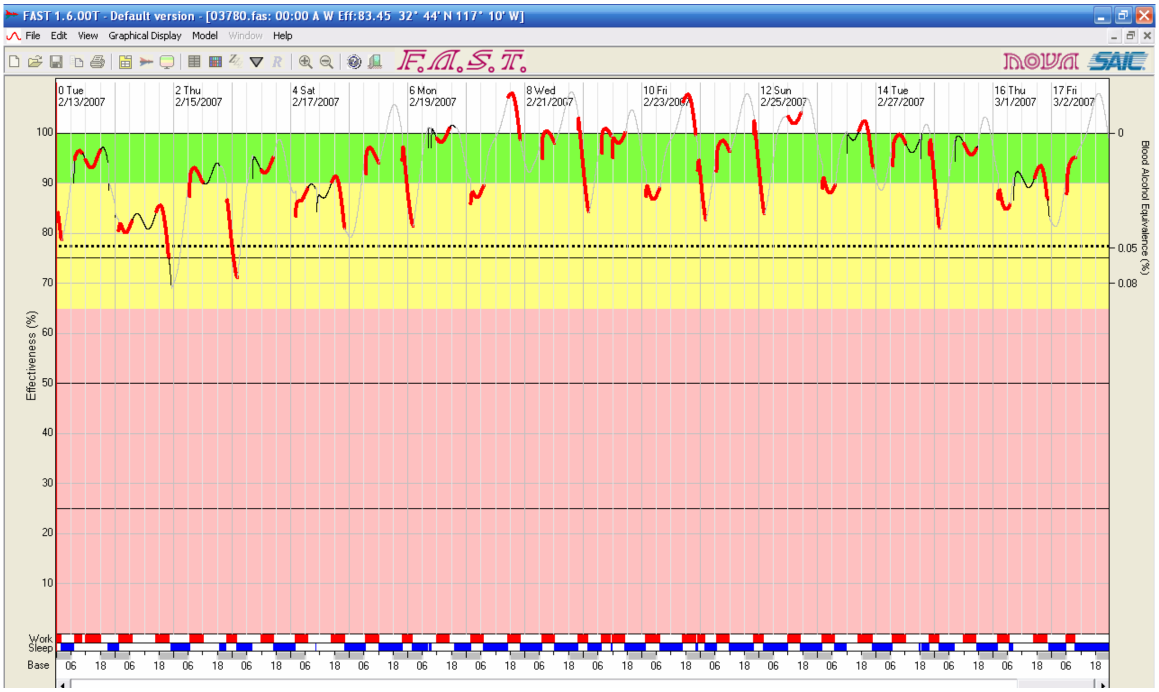
3772


FAST 1.6.00T - Default version - [03774.fas: 00:00 A W Eff:83.45 32° 44' N 117° 10' W]
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base

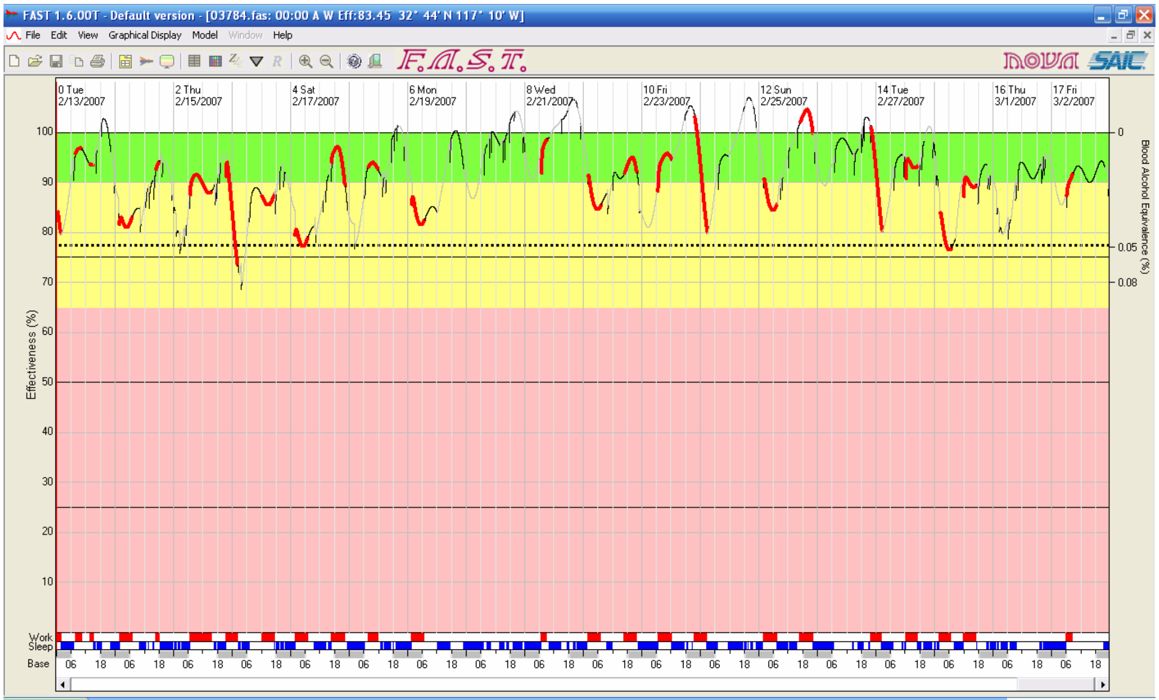
3774


FAST 1.6.00T - Default version - [03777.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
NOVA SAIC
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base

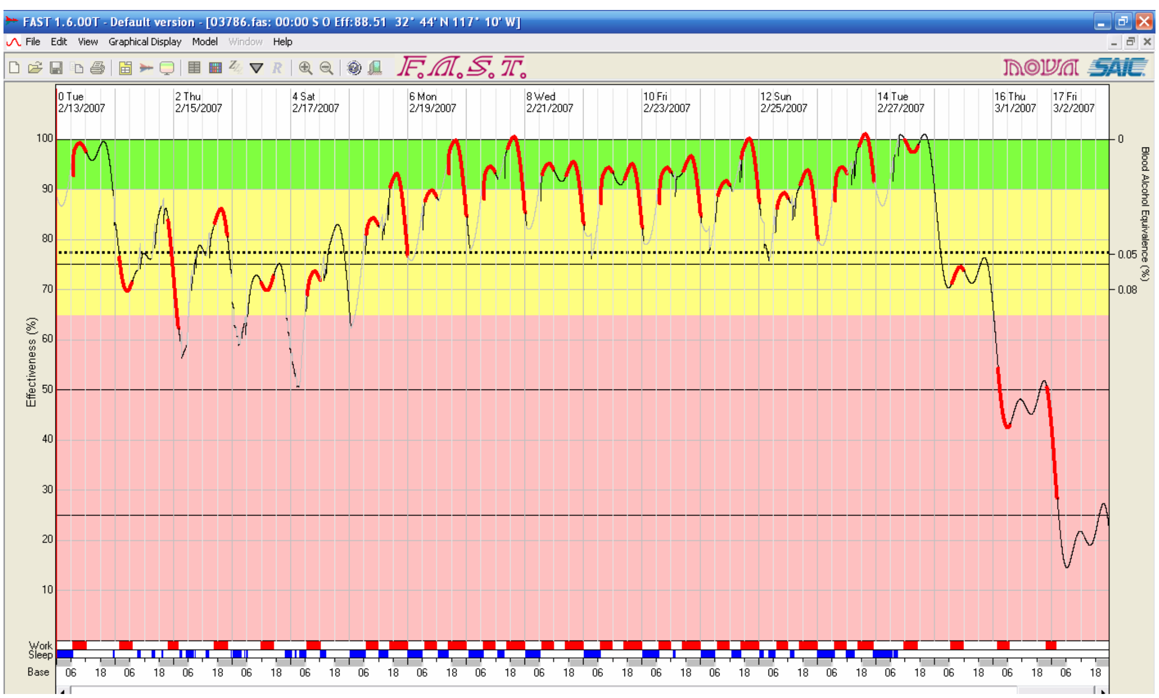
3777


FAST 1.6.00T - Default version - [03780.fas: 00:00 A W Eff:83.45 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
NOVA SAIC
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base

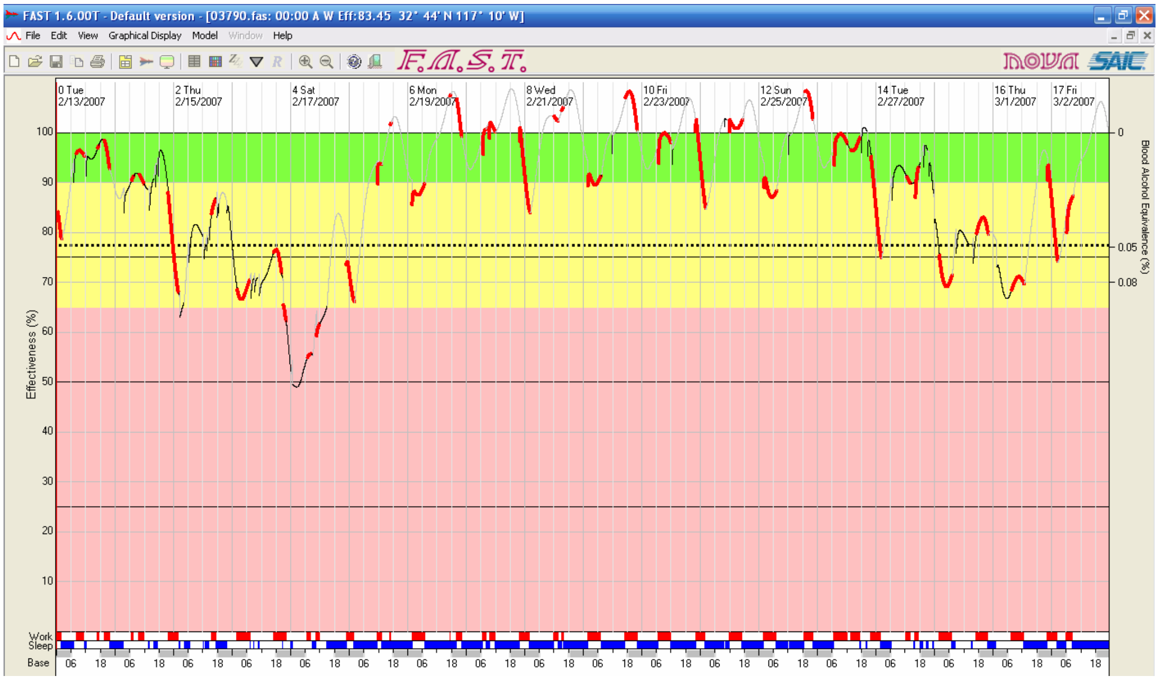
3780


FAST 1.6.00T - Default version - [03784.fas: 00:00 A W Eff:83.45 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
nova SAIC
0 Tue 2/13/2007
2 Thu 2/15/2007
4 Sat 2/17/2007
6 Mon 2/19/2007
8 Wed 2/21/2007
10 Fri 2/23/2007
12 Sun 2/25/2007
14 Tue 2/27/2007
16 Thu 3/1/2007
17 Fri 3/2/2007
Effectiveness (%)
Blood Alcohol Equivalence (%)
0.05
0.08
Work
Sleep
Base

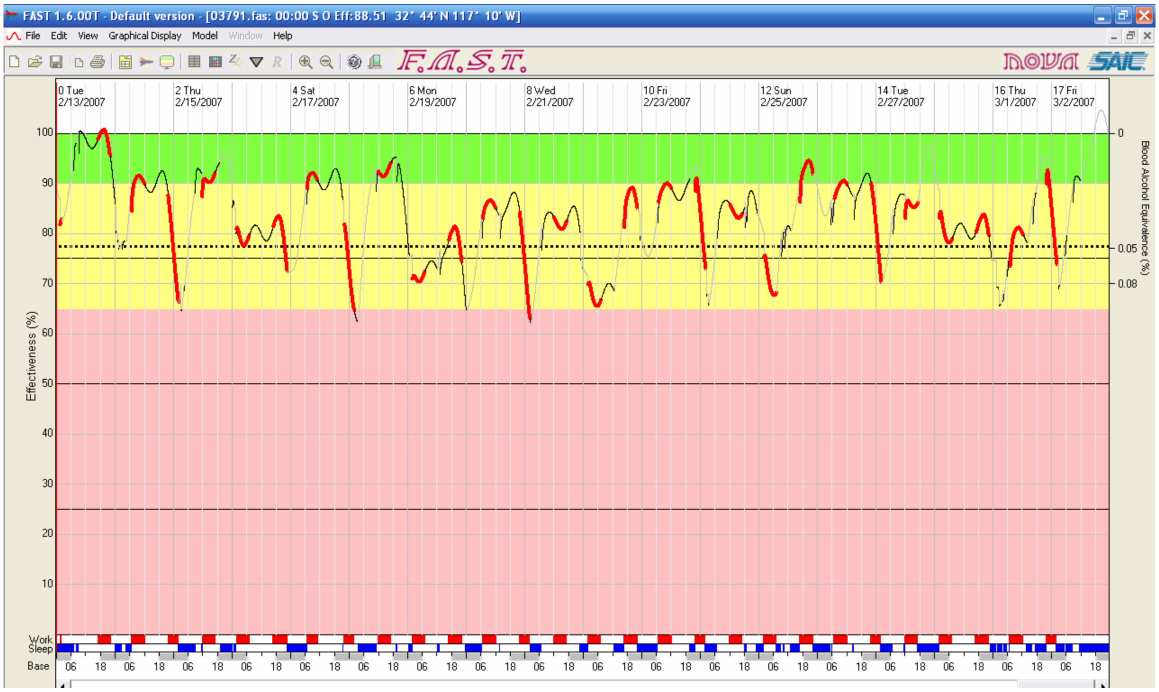
3784


FAST 1.6.00T - Default version - [03786.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
F.A.S.T.
nova SAIC
0 Tue 2/13/2007
2 Thu 2/15/2007
4 Sat 2/17/2007
6 Mon 2/19/2007
8 Wed 2/21/2007
10 Fri 2/23/2007
12 Sun 2/25/2007
14 Tue 2/27/2007
16 Thu 3/1/2007
17 Fri 3/2/2007
Effectiveness (%)
Blood Alcohol Equivalence (%)
0.05
0.08
Work
Sleep
Base

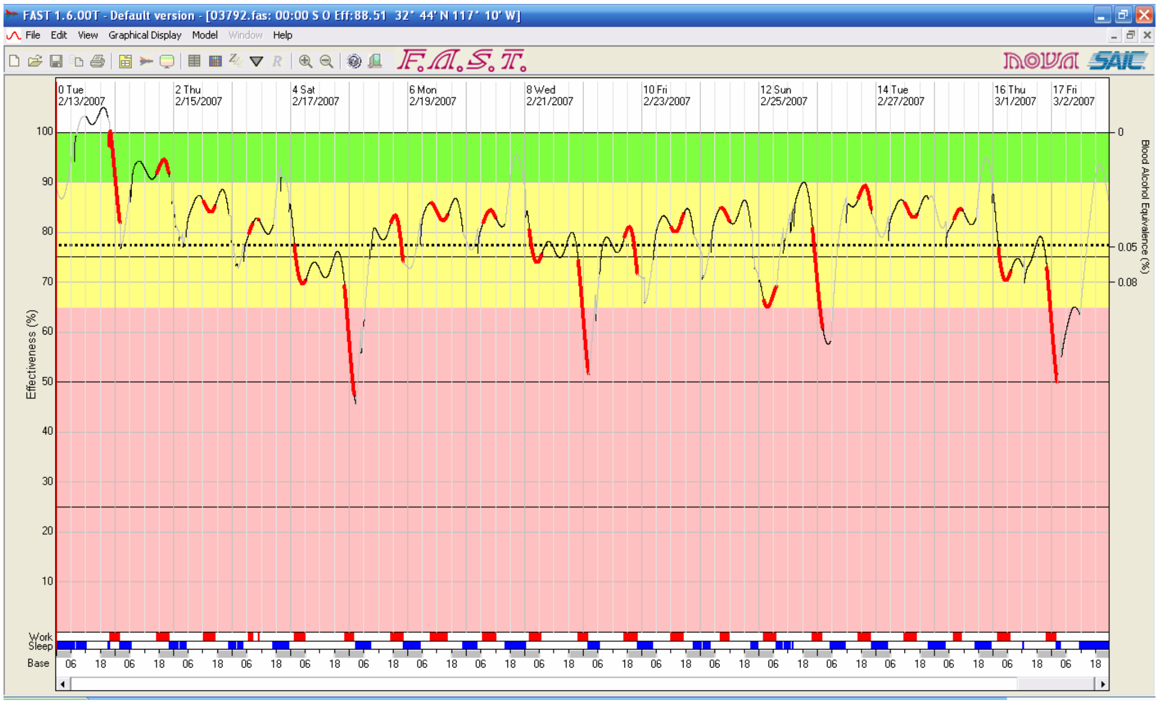
3786


FAST 1.6.00T - Default version - [03790.fas: 00:00 A W Eff:83.45 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base

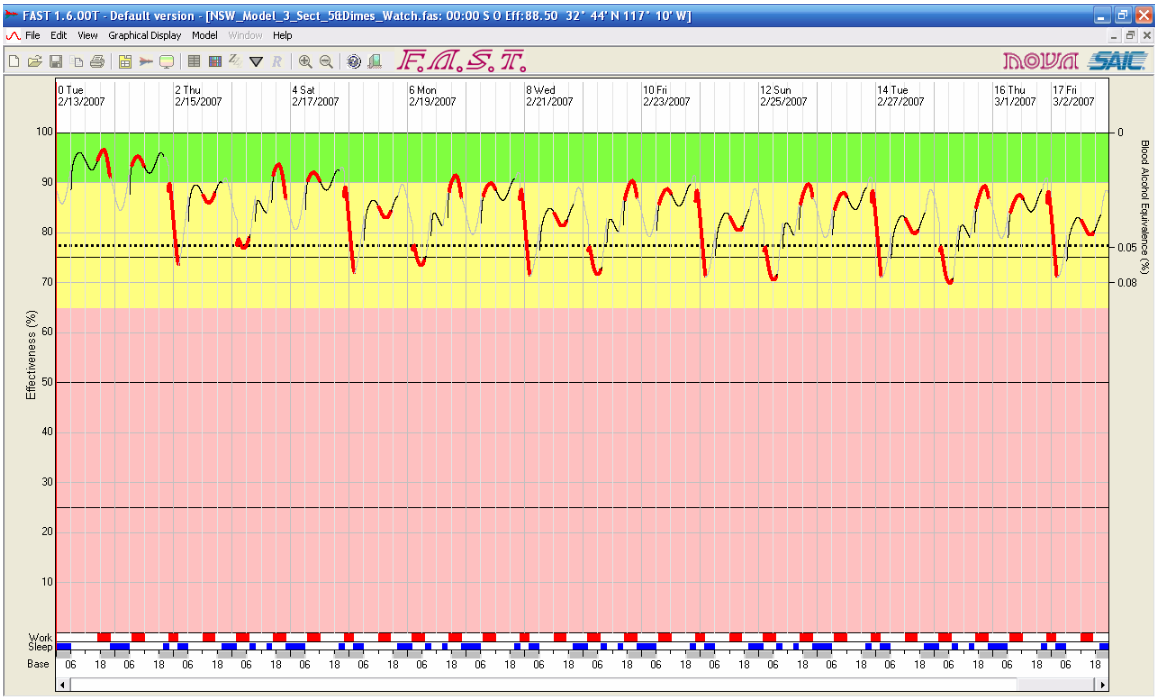
3790


FAST 1.6.00T - Default version - [03791.fas: 00:00 S O Eff:88.51 32° 44' N 117° 10' W]
File Edit View Graphical Display Model Window Help
Effectiveness (%)
Blood Alcohol Equivalence (%)
Work
Sleep
Base

3791



3792



Navy Standard Workweek Model

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX I. INDIVIDUAL SAILOR FAST SUMMARY DATA

The following tables display the FAST summary data for the individual Sailors. This table shows the average effectiveness for work, wake and sleep intervals. The table also shows average effectiveness for the 18 day period.

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	30	73	71
Last	3/2/2007	Mean	309	286.2	63
Average Sleep per Day	279	Median	315	75	30
Average Work per Day	515	SD	22.5	366.8	78.1
Average Effectiveness	64.73	Shortest	255	15	15
		Longest	345	1545	435
		Avg. Eff.	65.33	65.23	60.11

3688

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	36	48	46
Last	3/2/2007	Mean	351.3	412.2	108.9
Average Sleep per Day	341	Median	330	442.5	52.5
Average Work per Day	703	SD	98.4	387.5	119.7
Average Effectiveness	74.78	Shortest	60	15	15
		Longest	540	1335	375
		Avg. Eff.	77.43	75.5	68.54

3700

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	33	48	46
Last	3/2/2007	Mean	271.8	415.6	96.5
Average Sleep per Day	332	Median	300	382.5	52.5
Average Work per Day	498	SD	90.2	435.4	98
Average Effectiveness	58.3	Shortest	45	15	15
		Longest	465	1560	405
		Avg. Eff.	55.25	55.75	59.84

3722

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	21	54	52
Last	3/2/2007	Mean	248.6	359.2	90.3
Average Sleep per Day	363	Median	270	270	52.5
Average Work per Day	290	SD	64.3	368.7	94.2
Average Effectiveness	72.15	Shortest	15	15	15
		Longest	315	1455	375
		Avg. Eff.	69.95	71.84	69.11

3737

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	23	91	89
Last	3/2/2007	Mean	266.1	185.4	87.8
Average Sleep per Day	503	Median	315	45	45
Average Work per Day	340	SD	96.2	252.8	110.2
Average Effectiveness	85.79	Shortest	15	15	15
		Longest	345	1035	600
		Avg. Eff.	85.28	85.72	84.44

3746

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	24	69	67
Last	3/2/2007	Mean	355	192.8	164.6
Average Sleep per Day	701	Median	315	60	75
Average Work per Day	473	SD	60.4	212.5	215.1
Average Effectiveness	91.42	Shortest	255	15	15
		Longest	435	720	825
		Avg. Eff.	90.56	89	93.4

3753

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	28	42	40
Last	3/2/2007	Mean	394.8	491.8	109.5
Average Sleep per Day	293	Median	375	517.5	97.5
Average Work per Day	614	SD	86.2	434.1	91.8
Average Effectiveness	57.97	Shortest	255	15	15
		Longest	645	1965	420
		Avg. Eff.	56.35	56.62	59.84

3754

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	17	38	36
Last	3/2/2007	Mean	301.8	166.6	436.7
Average Sleep per Day	1088	Median	315	195	217.5
Average Work per Day	285	SD	41.7	144.8	468.3
Average Effectiveness	99.43	Shortest	210	15	15
		Longest	375	420	1650
		Avg. Eff.	96.95	97.58	99.83

3758

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	22	29	27
Last	3/2/2007	Mean	603.4	476.4	400
Average Sleep per Day	673	Median	697.5	690	450
Average Work per Day	738	SD	264.2	341.3	246.4
Average Effectiveness	94.42	Shortest	45	15	15
		Longest	930	930	750
		Avg. Eff.	94.23	94.23	94.53

3761

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	31	58	56
Last	3/2/2007	Mean	329	341.4	67.8
Average Sleep per Day	340	Median	360	375	45
Average Work per Day	567	SD	79.7	331.4	88.9
Average Effectiveness	55.69	Shortest	135	15	15
		Longest	435	1530	615
		Avg. Eff.	55.92	52.93	46.99

3764

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	35	68	67
Last	3/2/2007	Mean	338.6	312.1	62.7
Average Sleep per Day	260	Median	390	75	45
Average Work per Day	658	SD	56	390.5	45
Average Effectiveness	68.28	Shortest	180	15	15
		Longest	390	1215	210
		Avg. Eff.	72.44	69.56	59.84

3769

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	54	47	45
Last	3/2/2007	Mean	251.4	414.3	130.3
Average Sleep per Day	358	Median	330	120	90
Average Work per Day	754	SD	125.4	471.3	153
Average Effectiveness	81.58	Shortest	45	15	15
		Longest	450	1320	630
		Avg. Eff.	85.01	83	76.4

3771

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	44	62	60
Last	3/2/2007	Mean	254.7	310.4	82.5
Average Sleep per Day	371	Median	292.5	187.5	60
Average Work per Day	623	SD	131.5	348	71.7
Average Effectiveness	65.65	Shortest	30	15	15
		Longest	435	1260	345
		Avg. Eff.	62.11	63.24	67.08

3772

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	27	61	59
Last	3/2/2007	Mean	336.1	300	109.1
Average Sleep per Day	423	Median	330	195	60
Average Work per Day	504	SD	91.2	326.2	107.7
Average Effectiveness	80.72	Shortest	60	15	15
		Longest	435	1185	465
		Avg. Eff.	79.14	80.82	79.55

3774

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	0	23	21
Last	3/2/2007	Mean	0	361.3	594.3
Average Sleep per Day	978	Median	0	75	135
Average Work per Day	0	SD	0	436.4	1547
Average Effectiveness	95.4	Shortest	0	15	15
		Longest	0	1050	7065
		Avg. Eff.	0	89.56	97.15

3775

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	26	53	51
Last	3/2/2007	Mean	329.4	324.9	144.1
Average Sleep per Day	483	Median	315	120	90
Average Work per Day	476	SD	99.5	343.4	147.5
Average Effectiveness	82.44	Shortest	45	15	15
		Longest	435	1305	600
		Avg. Eff.	80.9	81.26	82.4

3777

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	33	35	33
Last	3/2/2007	Mean	288.6	386.1	340.5
Average Sleep per Day	689	Median	315	315	390
Average Work per Day	529	SD	54.1	273.9	213.4
Average Effectiveness	93.92	Shortest	120	15	15
		Longest	375	1290	600
		Avg. Eff.	93.19	92.82	94.61

3780

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	24	104	102
Last	3/2/2007	Mean	266.9	147.5	100
Average Sleep per Day	588	Median	315	60	45
Average Work per Day	356	SD	103.3	189.5	117.8
Average Effectiveness	91.54	Shortest	75	15	15
		Longest	525	945	525
		Avg. Eff.	89.46	91.66	91.38

3784

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	28	53	52
Last	3/2/2007	Mean	336.4	273.4	111.3
Average Sleep per Day	345	Median	315	180	60
Average Work per Day	523	SD	67.5	296.5	124.8
Average Effectiveness	79.29	Shortest	255	15	15
		Longest	435	1080	465
		Avg. Eff.	86.75	86.22	81.69

3786

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	41	57	55
Last	3/2/2007	Mean	181.1	228.9	211.6
Average Sleep per Day	715	Median	195	195	90
Average Work per Day	413	SD	102.4	191.7	219.6
Average Effectiveness	89.6	Shortest	15	15	15
		Longest	315	675	615
		Avg. Eff.	87.98	84.9	94.01

3790

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	29	55	53
Last	3/2/2007	Mean	291.2	324	131.3
Average Sleep per Day	450	Median	315	255	60
Average Work per Day	469	SD	57.1	351.1	143.4
Average Effectiveness	83.58	Shortest	30	15	15
		Longest	345	1275	525
		Avg. Eff.	83.07	83.82	81.37

3791

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	22	44	42
Last	3/2/2007	Mean	265.9	418	145
Average Sleep per Day	418	Median	300	150	112.5
Average Work per Day	325	SD	81.3	474.8	135.9
Average Effectiveness	80.33	Shortest	15	15	15
		Longest	420	1635	510
		Avg. Eff.	78.21	80.12	79.78

3792

Entire schedule		Intervals			
Total Days	18		Work	Wake	Sleep
First	2/13/2007	N	29	34	32
Last	3/2/2007	Mean	287.6	508.2	236.3
Average Sleep per Day	480	Median	300	345	240
Average Work per Day	463	SD	24.7	275.1	138
Average Effectiveness	84.46	Shortest	240	240	120
		Longest	300	960	480
		Avg. Eff.	84.09	84.97	83.15

Navy Standard Workweek

APPENDIX J. SUMMARY TABLE OF AVERAGE TIME SPENT IN EACH ACTIVITY BY RANK AND DEPARTMENT

AVERAGE TIME SPENT (HOURS)/WEEK								
	n	Watch	Maintenance	Training	Meeting	Sleep	Messing	Personal &Sunday
NSW		**56**	**14**	**7**	**4**	**56**	**14**	**17**
Officers	3	65.82	29.95	1.71	5.17	48.23	8.20	8.92
Enlisted	21	56.87	28.61	4.58	2.75	50.97	8.71	15.09
Engineering	6	55.89	26.08	8.45	2.67	50.66	8.57	14.82
OP & CS	15	57.26	29.62	3.03	2.78	51.09	8.76	15.19
OP	4	72.25	18.15	8.29	1.91	43.08	7.58	16.73
CS	11	51.82	33.79	1.11	3.09	54.01	9.19	14.63

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX K. FATIGUE COUNTERMEASURES

1. Preventing Fatigue

The following are recommendations taken from the Australian Fatigue Management Guide on preventing fatigue.

Impose sensible work demands and schedules

Maintain an appropriate diet

Foster morale

Avoid or reduce sleep debt

2. Managing Fatigue

The following are recommendations taken from the Australian Fatigue Management Guide on managing fatigue.

Enhance the quality of sleep by:

Creating conditions conducive to good sleep

If eating before sleep, choose foods high in carbohydrates

If eating close to sleep, eat snack size foods

Eat protein in the morning

Avoid stimulants prior to sleep

Prepare a "go-to-sleep" routine to wind down

Ensure personnel understand the importance of sleep

What the Commander can do:

Train subordinates on how to nap and obtain quality sleep

Include sleep requirements in operational planning

Allow adequate sleep before an operation

Monitor sleep periods for everyone, including yourself

Allow at least four or five hours of uninterrupted sleep

Adopt a more relaxed leadership style, when necessary

Be more deliberate when issuing orders and directions

Understand the effects of sleep loss

Attempt to provide environments that facilitate sleep

(Fatigue management guide, 2005)

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

Bradshaw, D. A., & Devereaux, A. V. (2001). The sleepy sailor. *Navy Medicine*. 21-25.

Chapman, S. (2001, April). The management of stress and fatigue amongst royal australian navy submariners. Commonwealth of Australia.

Cohen, D. B. (1979). *Sleep & dreaming Origins, nature & function*. Elmsford, NY: Pergamon Press Inc.

Coren, S. (1996). *Sleep thieves An eye-opening exploration into the science and mysteries of sleep*. New York, NY: Free Press Paperbacks.

Dement, W. C. (1999). *The promise of sleep*. New York, New York: Random House, Inc.

Fatigue management guide. Retrieved August 5, 2007, from http://www.deir.qld.gov.au/pdf/whs/fatigue_management2005.pdf.

Hursh, S. R., Redmond, D. P., Johnson, M. L., Thorne, D. R., Belenky, G, & Balkin, T. J., Storm, W. F., Miller, J. C., Eddy, D. R. (2004). Fatigue models for applied research in warfighting. *75*, A44-A53.

Hockey, R. (1983). *Stress and fatigue in human performance*. John Wiley & Sons Inc.

Guralnik, D. (Ed.). (1972). *Webster's new world dictionary of the american language* (2nd ed., New York: The World Publishing Company.

Merriam-Webster. Retrieved September 10, 2007, from Mirriam-Webster Online Dictionary Web site: http://www.m-w.com/

Monk, T. H. (1986).Advantages and disadvantages of rapidly rotating shift schedules - A circadian viewpoint. *Human Factors*. *28*, 553 - 557.

Murphy, P. (Ed.). (2002). *Fatigue Management During Operations: A Commander's Guide* Puckapunyal, Vic: Doctrine Wing Land Warfare Development Centre.

OPNAV INSTRUCTION 1000.16J. (1998). *Manual of Navy Total Force Manpower Policies and Procedures*

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, VA

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, CA

3. Mr. Wayne Wagner
   N1 Research Liaison to NPS
   Washington, DC

4. Mr. Ilia Christman
   N104
   Washington, DC

5. LT Stephanie Miller
   N134 Task Force Life Work
   Washington, DC

6. CDR Joanne Cunningham
   Commanding Officer
   Navy Manpower Analysis Center
   Millington, TN

7. Dr. Nita Lewis Miller
   Naval Postgraduate School
   Monterey, CA

8. CDR David L. Schiffman
   Naval Postgraduate School
   Monterey, CA

9. LCDR Adam Welter
   Executive Officer
   USS CHUNG-HOON (DDG-93)
   Pearl Harbor, HI

10. Captain Fred Drummond
    N122
    Washington, DC